AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

MAMPONG - ASHANTI

GROWTH AND YIELD PERFORMANCE OF TWO MAIZE (*Zea mays L.*) VARIETIES TO DIFFERENT WEED CONTROL REGIMES

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MASTER OF EDUCATION (M. Ed) IN AGRICULTURE

(CROP SCIENCE)

2023

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(7201910017)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF CROP AND SOIL SCIENCES EDUCATION, FACULTY OF AGRICULTURE EDUCATION, AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT, MAMPONG -ASHANTI IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION (M. Ed) IN AGRICULTURE

SEPTEMBER 2023

DECLARATION

STUDENT‟S DECLARATION

I, Williams Kyereh declare that, except for references to authors who have been duly acknowledged, this dissertation is the outcome of my original research under supervision and that this dissertation has neither in whole nor in part been presented in this University or elsewhere.

SIGNATURE………………………………..

DATE………………………………………..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of the dissertation laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Mampong – Ashanti.

Prof. (Mrs,) Margaret Esi Essilfie

SIGNATURE………………………………

DATE………………………………………

ACKNOWLEDGEMENT

Nothing could have been possible and completed without the Almighty God. I, therefore, thank God for protecting and guiding me through this project.

I am most indebted to my supervisor Prof. (Mrs,) Margaret E. Essilfie for her guidance, ideas, and suggestions which contributed immensely to the success of this dissertation. Her professional and academic recommendations were very useful. God richly bless her.

I wish to express my sincere appreciation to Dr Benjamin Aboagye Danso and Mr Stephen Asare, for their assistance, support, and suggestion in terms of equipment and technical advice during the project.

Many thanks also go to Mr Thomas Ofori and Mr Emmanuel Ofori my project partners, Mrs, Sarah Frema Opoku for her support and encouragement, the Authors whose works served as sources of information, and all the loved ones who contributed in one way or the other to make this project a reality.

DEDICATION

This work is completely dedicated to God Almighty, my wife, Eunice Adutwumwaa, my Father, Mr Christopher Kyere and my mother, Madam Mary Yeboaa for the unconditional love they show me. Special dedication also goes to my uncles Mr Isaac Effah Boakye and Mr George Yeboah and finally to my kids, Nhyira, Israel, and, Godswill.

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LIST OF ABBREVIATIONS/ACRONYMS

AAMUSTED	Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development
ANOVA	Analysis of variance
RCBD	Randomized Complete Block Design
CM	Centimeters
CSIR	Council for Scientific and Industrial Research
CV	Co-efficient of Variation
WAP	Weeks after planting
LSD	Least Significant Difference
MoFA	Ministry of Food and Agriculture
DAS	Days after sowing
SSA	Sub-Saharan Africa

ABSTRACT

The field experiment was carried out from August to December 2022 at the Research field of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Mampong – Ashanti. The main objective of the study was to determine the influence of different weed control regimes on the growth and yield performance of two maize varieties. The experimental design was 2×4 factorial laid in Randomized Complete Block Design (RCBD) with eight treatments replicated three times. The treatments were: Abontem variety + hoeing at 3, 5 and 7 WAP, Abontem variety + hoeing at 3 and 5 WAP, Abontem variety + hoeing at 3 WAP, Abontem variety + no hoeing, Omankwa variety + hoeing at 3, 5 and 7 WAP, Omankwa variety + hoeing at 3 and 5 WAP, Omankwa variety + hoeing at 3 WAP Omankwa variety + no hoeing. The results revealed that, Abontem variety recorded early days to 50% silking (59) which was significantly different ($P \leq 0.05$) from Omankwa variety which showed late days to 50% silking (64). The hoeing regimes significantly differed from the no hoeing in stem diameter at 7, 9 and 11 WAP. The varieties x hoeing regimes interaction significantly differed from the varieties x no hoeing interaction. Hoeing at 3 and 5 WAP produced significantly higher the yield than no hoeing. Omankwa variety × hoeing at 3, 5 and 7 WAP had significantly higher yield (836.10 kg/ha) than Abontem and Omankwa + no hoeing (81 and 87 kg/ha) respectively. It is therefore recommended that, farmers undertake hand hoeing at 3 and 5 WAP when planting early maturing maize varieties for higher vegetative growth and higher yield of maize.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

The cereal crop that is most widely grown and consumed in Ghana is maize, whose annual production is estimated to be 750,000 hectares (Tetteh *et al.,* 2017). Smallholder farmers with little resources mostly grow maize under rainfed circumstances (Afreh *et al.,* 2022). As a traditional staple food crop in northern Ghana, it has almost completely replaced millet and sorghum as major sources of calories (Darfour & Rosentrater, 2016). Nevertheless, it has steadily grown into a significant commercial crop and is used as a raw ingredient in several agro-related businesses (García-Lara & Serna-Saldivar, 2019). According to Ragasa *et al.* (2014), small-scale farmers may end family hunger by cultivating maize, and the combined impact might triple food output in Africa (Imoloame, 2020). The intake of grains was impacted by many customs and cultures, and a significant portion is utilized as feed in the poultry business (Abd *et al.*, 2022).

However, weed infestation is the reason why maize is unable to generate more substantial grains (Ragasa *et al.,* 2018). Additionally, according to Afreh *et al.* (2022), the decrease in maize production might be due to drought, pests, sparing use of enhanced seeds and fertilizers, as well as low soil fertility. Throughout the past, maize (*Zea mays L.*) was grown in Africa on a small basis for sustenance (Ragasa *et al.,* 2014). In maize production systems, weeds significantly reduce yields and are a major impediment to crop production. Herbicides are frequently employed to manage weeds in maize production systems, although they may have unfavourable environmental effects. Mechanical weed control can at different stages of plant growth help improve the yield (Ten *et al.,* 2019).

1.2 Problem statement

In Ghana, maize is broadly appreciated as a stable crop and it is grown in all agro-ecological zones. More than 50% of rural households cultivate it, traditionally under rain-fed conditions. In addition, 16% of urban households are involved in its production (Villano *et al.,* 2019). However, according to Asante *et al.* (2019) the yield gap is severe, especially in the northern part of the country. Average maize yields fluctuate between 1.2 and 1.9 metric tons (Mt) per hectare (ha), whereas on-station and on-farm trials suggest that yields average between 4 and 6 Mt/ha of maize are attainable in the country (Ngoune & Mutengwa, 2019). Hall *et al.* (1992) have indicated that agricultural production is below production potential, especially for maize yields, is a common phenomenon in most African countries. Weeds infestation is regarded as one of the primary factors limiting maize crop productivity among many biotic (insect, pest, predators, weed, fungi, bacteria etc.) and abiotic (drought, salinity, heat, etc.) and poor agronomic practices (tillage, fertilizer application etc) (Rajeshkumar *et al.,* (2017).

In general, weeds infestation can significantly reduce maize output and, in rare cases, completely destroy the maize plant (Sharma & Rayamajhi, 2022). According to (Lati *et al.,* 2021) weed has terrible impacts on grain quality due to the mixing of weed seeds, which eventually lowers the crop's value. By competing with the primary crop plant for nutrients, light, and water as well as occasionally producing compounds that are deemed toxic to the related crop, it also has a detrimental effect on crop productivity. Consequently, weed infestation is still viewed as a serious economic issue in the maize industry. Weed infestation is one of the elements linked to the discrepancy between potential and actual maize yields in Africa. In its early phases of growth, maize is particularly vulnerable to weed competition (Islam *et al.,* 2021). Mhlanga *et al.* (2016), claimed that weeds frequently result in catastrophic losses to maize crops. They are responsible for 50 to 90% of crop losses in Africa on average. For instance, *Striga asiatica* (L.) has been observed to invade maize fields in Africa and in some circumstances, completely destroy the crop (Khan *et al.* 2016). Despite complaints that chemical weed management leaves hazardous residues in the environment, it has been reported to be an alternative to manual weeding (Imoloame, 2021). According to Sadras & Lawson, (2011) lack of knowledge on the proper amounts of herbicide application leads to the indiscriminate application of the chemical weed control approach. Herbicide-resistant weeds, herbicide residues in crops, and health risks might all result from these issues (Best-Ordinioha *et al.,* 2017). Small-holder farmers in Africa continue to mostly use manual weed control as a weed management strategy (Verret *et al.,* 2017). Based on the varieties, previous studies have shown that two mechanical weed control methods at 3 and 6 weeks after sowing produced successful weed control and high maize yields (2,814.80 kg/ha) (Imoloame, 2017; Imoloame, 2020a; Peerzada *et al.,* 2019).

1.3 Justification

According to Mekonnen, (2017), weeds have a significant biological role in agricultural production, contributing to around 45% of crop yield loss. Understanding the important period for agricultural weed competition, how weeds affect plant growth and development, physiological changes, yield performance is very important to controlling weeds. Increased initial weed competition period lowers crop germination and lowers the growth and development parameters later in the crop's growth (Akter *et al.* 2016). Similar to this, increased weed competition significantly lowers agricultural output (Imoloame & Omolaiye, 2017). At the Bilatte and Shewa Robit tobacco farms in Ethiopia, an experiment carried out with the aim of determining the impact of hand weeding frequency on flue-cured tobacco growth traits and output. According to the experimental findings, tobacco yield and growth characteristics were influenced by the frequency of different hand weeding levels. Especially at 15, 30, 45, 60, and 90 days after transplanting, weeding tobacco four or five times resulted in a comparatively higher yield (Abebe, 2020). At Sirinka, two-hand weeding and hoeing at 2 and 5 weeks after establishment of cowpea Jari, one hand weeding and hoeing produced the maximum total dry biomass (12413 kg ha-1). According to the findings, the most practical method was the employment of a planting pattern of 60 cm x 10 cm combined with hand weeding and hoeing at 3 weeks after establishment at Sirinka and at 4 weeks after establishment at Jari (Mekonnen, 2017).

A field experiment carried out at the Agricultural College and Research Institute in Madurai, Tamil Nadu Agricultural University in 2013 revealed that Pendimethalin treatment at 0.75 kg/ha plus rotary hoeing at 35 days after sowing resulted in considerably enhanced grain production of maize at 6051 kg/ha (Rajeshkumar *et al.* 2017). At the Kwara State University Teaching and Research Farm in Nigeria, field tests were carried out in the growing seasons of 2013 and 2014. For 3WAS, plots that underwent weed interference generated considerably greater yields that were at par with the maximum. In order to get the best yield, it is evident from the most recent research that the maize plot needs to be kept weed-free between 3 and 6 WAS, which is the key period for weed interference (Imoloame & Omolaiye, 2017). The studies above have not considered the weed control regimes on early maturing varieties of maize that would result in higher yields. This study therefore is to determine the effects of weeding regimes on two early maturing maize varieties, growth and yield.

1.4 Objectives of the Study

1.4.1 The Main Objective

The main objective of the study was to determine the influence of the different weed control regimes on the growth and yield performance of two early maturing maize varieties.

1.4.2 Specific Objectives

The specific objectives were to:

a. Determine the influence of different weed control regimes (hoeing at 3, 5 and 7 weeks after planting; hoeing at 3 and 5 weeks after planting; hoeing at 3 weeks after planting; and no hoeing weedy check) on the growth of two maize varieties (*Abontem* and *Omankwa*).
b. Assess the effect of different weed control regimes on the yield of the two maize varieties.
c. Compare the effectiveness of different weed control regimes on the yield components of the two maize varieties.

CHAPTER TWO

2.0 LITEREATURE REVIEW

2.1 Origin and Distribution

Mesoamerica, which is now Mexico and Central America, was where maize first appeared on earth. Maize was domesticated in parts of the southwestern United States, Mexico, and Central America for more than 6000 years, according to archaeological evidence (Pordel *et al.* 2021). In addition to China, India, and the Philippines and East Indies, the Portuguese also brought maize to these countries. The cultivation of maize is currently widespread in many nations, including those in the USA, China, Brazil, Argentina, Mexico, South Africa, Romania, Yugoslavia, and India. Following Columbus' return from the New World, maize was brought to Spain, and from there it travelled to France, Italy, and Turkey (Warman, 2003). The Balsas River Valley in south-central Mexico, which is close by, is currently thought to be the core of domestication in Mexico, according to research conducted in the twenty-first century (García-Lara & Serna-Saldivar, 2019).

According to a research by Bruinsma (2017), all maize originated from a single domestication in southern Mexico around 9,000 years ago, refuting the theory of many distinct domestications. The study also showed that the highland varieties of maize from Mexico are the oldest varieties still in existence. Maize later travelled over two main routes from this region to the Americas. This is in line with a theory based on the archaeological record that claims maize first evolved in Mexico's highlands before dispersing to the lowlands. The maize crop is highly suited and thrives in the majority of Ghana's ecological zones, including the northern savannah, according to Wongnaa & Awunyo-Vitor, (2019). In many areas of Ghana, it is the main source of calories. In northern Ghana, it has taken the place of sorghum and pearl millet, two traditional staple crops. While a feasible yield of roughly 6.0 t/ha is thought to be possible, the typical yield of maize grains on farmers' fields (Altieri & Nicholls, 2018).

2.2 Botany

Although certain wild strains of maize may reach a height of 13 m, the average maize plant is only 3 m tall. Each node produces a leaf, which typically has a width of 9 cm and a length of 120 cm. In the middle of the plant, between the stem and the leaf sheath, ears form above a few of the leaves. They grow around 3 millimetres every day, reaching a maximum length of 60 cm in the subspecies. There are female inflorescences, which are securely encased in a number of ear leaf layers known as husks. A large number of extra developed ears have been bred into several maize cultivars. This is where the "baby corn" that is a vegetable in Asian food comes from (Warman, 2003). Tassels, which are inflorescences of male flowers, at the tip of the stalk. Anthers on the tassel dehisce and release pollen when the tassel reaches maturity and the surrounding climate is warm and dry (Sun *et al.,* 2017).

The majority of the pollen from maize falls within a few metres of the tassel because the pollen is anemophilous (dispersed by wind) and has a high settling velocity (Soujanya *et al.,* 2016). According to Lizaso *et al.* (2018), silks elongated stigmas emerge from the whorls of husk leaves near the ear. They frequently resemble hair spikes in appearance and are 18 cm long. A carpel, which may grow into a "kernel," is present at the end of each and is fertilized by a pollen particle. The entire kernel of the fruit, which is frequently referred to as the "seed," is fused with the characteristic of grasses "caryopsis," or seed coat. Structure-wise, the cob is very similar to a multiple fruit, but the individual fruits (the kernels) never combine into a single mass. The grains, which are roughly the size of peas, form the ear by adhering in regular rows around a white, pithy substance. The maize grain comes in a variety of hues, including blackish, bluish-gray, purple, green, red, white, and yellow (Soujanya *et al.,* 2016). In the environment to which it is evolved, maize, a facultative short-day plant, blooms in a certain number of growing degree days when the temperature is higher than 10 ^{o}C.. The photochromic system controls and genetically predetermines how much of an impact a long night has on how many days it takes for maize to blossom (Baret *et al.,* 2018). The lengthy days typical of higher latitudes allow plants to grow so tall that they do not have enough time to develop seed before being destroyed by frost. This is because photoperiodicity in tropical cultivars can be erratic. However, these qualities could be advantageous for utilizing tropical maize for biofuels (Popp *et al.,* 2016). Due to its shallow roots, maize is vulnerable to drought, intolerable to nutrient-deficient soils, and easily uprooted by strong winds (Hochholdinger *et al.,* 2018). The colours of red and yellow maize are produced from anthocyanin and phlobaphenes, respectively, while lutein and zeaxanthin give yellow maize its colour (Ekpa *et al.,* 2018).

2.3 Nutritive Value and Uses

In sub-Saharan Africa, maize is a staple meal for more than 50% of the population. According to proximate analysis of seeds, it has a significant amount of carbs, a little amount of protein, fat, and fibre. Calcium, iron, magnesium, salt, zinc, vitamin C, thiamine, riboflavin, and vitamin B-6 are additional minerals (Dei, 2017).Some minerals found in maize serve as antioxidants. It contains a lot of carbohydrates, fibre, important proteins, and oil. It may include vitamin C, vitamin B, folic acid, and provitamin A, depending on the type (Edima-Nyah *et al*., 2020). Maize is a rich source of carotenoids such as beta-carotene, zeaxanthin, lutein, and cryptoxanthin, according to (Hussain *et al.,* 2019). Many African cuisines and beverages are made with maize as an ingredient. The stem is used as feed for a wide variety of agricultural animals, while the uncooked grains are fed to animals, particularly chickens (Zeffa *et al.*, 2019). Only 30 crops supply 90% of the calories needed by the globe, with wheat, rice, and maize accounting for nearly 50% of the calories consumed. The starch found in the kernel is utilized in the making of paper, glue, textiles and many other goods. The starch may also be transformed into sweeteners that are used in a variety of items, including soft beverages, candies, baked goods, and jams. The oil from the embryo is used to make margarine and culinary oils. In chicken feed, the hulls and the soluble components of the kernel are employed (Dowswell, 2019).

In Ghana, the national consumption of maize in 2000 was estimated to be 42.5 kg per capita, while in 2006, it was expected to be 943000 Mt. (Azumah *et al.*, 2022) According to reports, Ghana markets a million metric tonnes of maize each year. The primary staple food for producers' homes is still the enormous amount of maize grains that are produced (Dowswell, 2019). Cakmak *et al.* (2017) in a study claimed that maize grain is consumed in a variety of ways across traditions and cultures, with a sizable amount of the grain being utilized as feed for chickens. Only 20 to 25 per cent of the world's maize market is used for processing and other industrial uses.

2.4 Varieties

There are nearly 50 different species of maize, each with its own distinctive traits and kernel sizes, and they all fall into a small number of categories. White, red, and yellow are the most prevalent fundamental colours of maize, while the structure and form of the kernel vary according on the species (Dowswell, 2019). The grain colour, texture, and average yield of certain typical maize cultivars in Ghana are detailed (tonnes per hectare). In Ghana, the Crop Research Institute of CSIR has published the common varieties Aburohemaa, Omankwa, Abontem, Obatanpa, Mamaba, and Dodzi (Poku *et al.*, 2018).

In Ghana, there are both openly pollinated varieties (OPV) and hybrids that have been locally adapted. Hybrids respond well to high management levels and are well adapted to favourable production situations. Hybrids have better genetics than OPVs, such as high production potential and special trait combinations to withstand challenging growing environments. Once more, hybrid plants react to fertilizer treatment better than OPV plants. However, every planting season requires the procurement of fresh seeds in order to maintain hybrids' highest production (Danso-Abbeam *et al.,* 2017).

Table 2.1: Released Varieties of Maize by Crop Research Institute of CSIR, Ghana

Name of Variety; National Code; Origin/ Source	**Distinctness Uniformity and Stability (DUS)**	**Distinctness Uniformity and Stability (DUS)**	
Obatanpa GH/Zm/002/15 CSIR-CRI/CIMMYT	Type of variety: OPV; Maturity: 110 days; Potential yield (tons/ ha): 4.6; Seed colour: white; Days to 50% silk: 55; Plant height (cm): 175; Ear height (cm): 80; Tassel colour: cream purple; Tassel arrangement: Open and alternate; Silk colour: cream purple; Stem colour: Green with purple shade; Cob length (cm): 15.2; Cob diameter (cm): 4.8; Kernel depth (cm): 1.3; Kernel arrangement: straight; Kernel type: dent	Quality Protein Maize (QPM). Excellent for enhanced nutrition and health of humans, poultry and livestock	All agro-ecologies in Ghana

Table 2.2: Released Varieties of Maize by Crop Research Institute of CSIR, Ghana CONT.

Name of Variety; National Code; Origin/ Source	Distinctness Uniformity and Stability (DUS)	Distinctness Uniformity and Stability (DUS)	
CSIR-Omankwa GH/Zm/012/15 CSIR-CRI/IITA	Type of variety: OPV; Maturity: 90days; Potential yield (tons/ ha): 5.0; Seed colour: White; Days to 50% silk: 54; Plant height (cm): 182; Ear height (cm): 91; Tassel colour: purple shade; Tassel arrangement: Open and alternate; Silk colour: purple; Stem colour: Green with purple shade; Cob length (cm): 15.7; Cob diameter (cm): 4.5; Kernel depth (cm): 1.2; Kernel arrangement: straight; Kernel type: Flint/dent	QPM yellow. Good for poultry and livestock	Most suitable for Guinea and Sudan savannah Zones
CSIR-Abontem GH/Zm/013/15 IITA, Ibadan	Type of variety: OPV; Maturity: 75-80 days; Potential yield (tons/ha): 4.7; Seed colour: yellow; Days to 50% silk: 54; Plant height (cm): 162; Ear height (cm): 82; Tassel colour: cream purple shade; Tassel arrangement: Open and alternate; Silk colour: purple; Stem colour: Green with purple shade; Cob length (cm): 15.5; Cob diameter (cm): 4.4; Kernel depth (cm): 1.1; Kernel arrangement: straight; Kernel type: Flint/dent	QPM yellow. Good for poultry and livestock	Most suitable for Guinea and Sudan savannah Zones

Source: CSIR, 2019.

2.5 Production estimates

The global maize area (for dry grain) amounts to 197 M ha, including substantive areas in sub-Saharan Africa (SSA), Asia and Latin America (FAOStat, 2018). It is an established and important human food crop in a number of countries, especially in SSA, Latin America, and a few countries in Asia, where maize consumed as human food contributes over 20% of food calories (Ekpa *et al.* 2018). Compared to wheat and rice, maize is a more versatile multi-purpose crop. In the developed economies it is primarily used as a livestock feed crop with a varied role as an industrial and energy crop (N. Sharma & Rayamajhi, 2022). With economic development (including income growth and urbanization), the consumption of animal source foods is accelerating and propelling the demand of maize as feed, Asia being a prime example (Du Plessis, 2003). Maize for dry grain is annually cultivated on an estimated 197 M ha of land globally, making it the second most widely grown crop in the world after wheat.

In terms of (dry grain) annual production, maize's 1,137 million tons (M t) globally is markedly higher than both rice and wheat (Ngoune & Mutengwa, 2019). The divergence reflects the substantially higher maize grain yields (5.8 tons/ha), mostly linked to widespread hybrid cultivation and complementing input use. Over the last quarter century, maize production more than double supported by both substantive yield increases and area expansion. Of the three cereals, maize had a yield increase of nearly 2 tons over the 25-year period (up from 3.9 tons/ha, i.e., an increase of 76 kg/ha/yr or a simple average of 2.0% per annum [pa]), compared to increases of 1 ton for rice and wheat (increases of 39 and 40 kg/ha/yr, or simple averages of 1.1 and 1.6% pa respectively) (Dowswell, 2019).

Ghana has been cultivating maize for many years. In Ghana, maize is a common cereal crop that is both grown and consumed, and its output has been expanding since 1965

(Danso-Abbeam *et al.* 2017). The annual total production of maize in 2018 was 2306.38 metric tons on 1020.52 hectares of cultivated (MoFAStats (2017). The five major regions of cultivation from 2016 to 2018 were Eastern region, Brong Ahafo region, Ashanti region, Northern region and Central region. The leading producer was Eastern region with total amount of 447,933.75 Mt (Azumah *et al.* 2022). The annual production grew by 4.9% in 2018. The annual production under rainfed conditions was 2.26 Mt/ha which is below the potential yield of 5.50 Mt/ha. West Akim District produced the highest metric tonnes of maize (4.05 Mt) which was above the country's annual production (Poku *et al.* 2018).

2.6 Climatic and soil requirements

2.6.1 Climatic requirements

Maize is a crop that may be cultivated in a variety of conditions, including wet, hot, cold, and dry ones. The maize crop is farmed in a variety of climates and is predominantly a warm-weather crop (Du Plessis, 2003). However, because the plant cannot tolerate freezing temperatures, maize must be planted in the spring in temperate regions (Ileri *et al.* 2018). According to Bagula *et al.* (2022), maize does best between 600 and 900 mm of yearly rainfall and needs more than 500 mm to flourish. The optimum rainfall typically range between 1200 and 1500 mm equally dispersed throughout the year, and the rainfall should be properly distributed throughout the growing season (Bessah *et al.* 2022). Drought during anthesis prevents pollination and significantly reduces production. Rainfall is especially important at the tasseling and silking phases (Du Plessis, 2003). The optimum temperature for the highest yield is 30 ^{o}C. High temperatures shorten the harvest whereas cold temperatures prolong the maturity period. Maize has the highest yield per hectare of all grain crops and is the crop that makes the best use of sunshine. Depending on the species, it thrives in a wide range of agro-ecological zones between 0 and 2200 m above sea level. Poor yield is the result of very low or high elevations (Ileri *et al.* 2018).

2.6.2 Soil requirement

The ideal soil for growing maize is one that has the following characteristics: a good effective depth, favourable physical properties, good internal drainage, an ideal moisture content, enough and balanced amounts of plant nutrients, and chemical properties that are particularly suited for growing maize (Ragasa *et al.*, 2014). A rich, well-drained soil is necessary for maize. It is best to use clay and alluvial loams with a pH of 5.0 to 7.0 (Darfour & Rosentrater, 2016). Nevertheless, maize can grow effectively in most soils. According to Ngoune & Mutengwa (2019), maize typically needs high to moderate levels of organic matter and nutrients, as well as a pH range of 5.5 to 8.0, for the greatest productivity.

2.7 Agronomic practices

2.7.1 Fertilizer application

When organic manure is used to grow maize, the soil's quality and ability to retain water are increased, which is good for the plant and the environment. Mineral fertilizers will speed up the onset of vegetative growth and provide nutrients during the active period of plant growth. The majority of the fertilizer used to grow maize is mineral fertilizer, which is periodically supplemented with manure and other techniques including crop rotation with legumes (Tetteh *et al.* 2017). A lot of nutrients are needed for maize, with potassium, phosphorus, and nitrogen being the three most crucial ones (K). Nitrogen is the essential nutrient that commonly results in yield decline among the others (Ragasa *et al.* 2014). It determines the yield potential of the plant since it affects the quantity of leaves and seeds the plant produces, as well as the number of seeds per cob. The quantity of mineral fertilizer that has to be applied varies according to the soil's levels of P and K, as well as its degree of moisture. In addition, the optimal fertilizer application for maize depends on a number of factors, including the variety's yield, past cropping patterns, cultural practices, and the general fertility of the land (Darfour & Rosentrater, 2016; Tetteh *et al.*, 2017).

2.7.2 Weed control

A plant that is considered a weed is one that is growing where it is not wanted, typically amid crops or garden plants. Weed incursion is becoming a major issue in maize because of its consistent early growth rate (El-Metwally & El-Wakeel, 2019). Weeds compete with the plants for primary crop for nutrients, soil moisture, and solar radiation, which has a significant impact on the phenology and morphology of the main crop. Although not all undesirable plants are weeds, all weeds are undesirable plants. Plants are not regarded as weeds if they develop without obstructing the primary crop plant (Du Plessis, 2003). Weeds must never be permitted to outgrow maize since it is most vulnerable to weed contests in its early phases of growth (Tursun *et al.* 2016). The crucial 2-4 weeks after planting is when weeding has the biggest impact on grain output.

There are different ways of weed management in maize cultivation such as physical management, cultural management, biological management and chemical management. The physical technique entails mowing, hand hoeing, tillage, digging and sickling, burning, floods, and trimming. Tillage includes the mechanical management of the soil for increased production, according to Sharma & Rayamajhi, (2022). Deep tillage helped to achieve the desired weed control by either burying weed seeds deeper into the soil or by destroying the roots of perennial weeds. According to Osman *et al.* (2020), chopping, crumpling, and breaking the stems is the most effective approach to manage weed. Numerous tillage techniques in maize, such as ploughing followed by a disc harrow, had the least amount of weeds and the highest yield characteristics, such as dry cob weight and grain weight whereas zero tillage has the most weeds and the least amount of grain production (Janmohammadi *et al.*, 2017). According to Imoloame, (2021), hand weeding at 50 DAS was responsible for the greatest results on weed biomass and concentration decrease, as well as a considerable increase of 42% in maize yield. In comparison to no interculture at 30 DAS, Sharma *et al.* (2016) found that hoeing at 15 DAS checked all weed species in terms of their development and that their number was also lower.

Osman *et al.* (2020) showed that hoeing at 20 DAS followed by two hand weeding, one at 20 DAS, and one at 40 DAS, significantly increased the effectiveness of weed control. Increased hoeing frequencies significantly increased total production (from 2.543 to 14.900 tha1) and commercial no husks fresh ear production (from 2.003 to 11.637 tha1), as well as physiological factors like plant height and mass, cob mass with husks and without husks, green mass, cob length, cob diameter, and stem diameter, but not cob ratio (Bist *et al.,* 2023). Crop rotation, crop competition, mulching, intercropping, and other agronomic techniques are all included in the cultural approach of weed management. Intercropping maize and legumes may reduce the amount of light that weeds have access to, according to (Verret *et al.*, 2017). Weeds and maize compete for space, nutrients, light, soil moisture and light, which reduces yields, lowers grain quality and raises production costs. Insects are also carried by weeds. According to Imoloame, (2017) two hand weeding at the third and sixth weeks after planting for weed control is appropriate. If required, you can repeat weeding before harvest. Despite complaints that it leaves hazardous leftovers in the environment, chemical weed management has reportedly been found to be a superior option than hand weeding. This is due to the fact that it is more affordable, quicker, decreases drudgery, provides better weed control, and boosts crop biological production. However, because the majority of farmers are uneducated and unaware of the proper herbicide application dosages, they utilize this weed management strategy carelessly. These issues have the potential to lead to health risks, herbicide-resistant weeds, environmental contamination, and weeds that are resistant to herbicides. The right minimum herbicide rates for the major herbicides used on maize must be determined (Ragasa *et al.*, 2014; Afreh *et al.*, 2022).

2.7.3 Pest and disease control

Pests and disease cause a loss of 18–26% of the world's yearly agricultural production, which is equivalent to an estimated $470 billion (Mantzoukas & Eliopoulos, 2020). Prior to harvest, the field experiences the majority of the losses (13–16%) (Mantzoukas & Eliopoulos, 2020). Maize production is a critical aspect of agriculture globally, and pest disease control is essential for improving maize yields and overall crop health. Pest and disease are controlled by the use of either biological control method, integrated pest management, host plant resistant, chemical control method or cultural control method (Liliane & Charles, 2020).

Moreover, a significant portion of agricultural product storage losses are attributable to post-harvest pests. Due to poor pest and disease control methods, between 50–60% of grains in storage may be lost over the storage term (Ons *et al.*, 2020). More than 500 species of arthropod pests are now resistant to one or more pesticide classes as a result of heavy chemical usage (Dewar & Denhol, 2017). The maintenance and growth of crop yields around the globe have been attributed to crop protection by agrochemicals.

Nevertheless, its widespread and sometimes negligent use has reduced the effectiveness of natural control mechanisms by leading to pest resistance, the comeback of secondary pests, and the disruption or destruction of natural enemy complexes (Samada & Tambunan, 2020).

2.8 Effects of weeds on growth and yield of crops

Weed competition reduces crop yield. Many studies have demonstrated that weed competition can reduce crop yield significantly (Maxwell, 2017). A study by Ramesh *et al.* (2017) showed that weed competition reduced rice yield by up to 68% in Australia. According to (Mashingaidze *et al.*, 2012) weed competition reduced maize yield by up to 50%, with the greatest impact on early-season weed growth. Other study conducted by (Girma *et al.*, 2022) found that weed competition reduced maize yield by up to 60% in Ethiopia. In addition to reducing crop yield, weeds can also reduce crop quality by interfering with crop growth and development. A meta-analysis of 94 studies conducted in 24 countries found that weed competition reduced crop yield by an average of 50%, with the greatest impacts on cereal and oilseed crops (Murdoch, 2018). Weed was found to reduce bean seed quality in the USA (Datta *et al.*, 2017). According to (Osipitan *et al.*, 2019), Weeds can also serve as hosts for pests and diseases that can attack crops, leading to further yield and quality losses. A study by Tursun *et al.* (2016) found that weeds were a major source of *Fusarium graminearum*, a fungal pathogen that causes head blight in wheat.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site and Location

3.1.1 Experimental site

The field experiment was carried out at the research field, Mampong Campus of Akenten Appiah-Menka University of Skill Training and Entrepreneurial Development (AAMUSTED) Mampong campus. Mampong is one of the six municipalities in the Ashanti region. Mampong the municipal capital is about 57 kilometers from the regional capital Kumasi. Mampong is located in the transitional agroecological zone of Ghana. In Ghana's transitional zone between a forest and savanna, Mampong Ashanti (7', 8^{o} N 1' 24^{o} W) is situated at an altitude of 457.5 m above sea level. The field trial was conducted from August through December, 2022.

3.1.2 Climatic Conditions

A bimodal rainfall pattern occurs in Mampong-Ashanti, with the major rainy season lasting from March to July and the minor rainy season lasting from mid-August to November. From December through March, there is a lengthy dry harmattan period. Mampong receives between 1412.2 mm and 1500 mm of rainfall yearly, with a mean monthly total of 91.2 mm. The monthly mean temperature of the experimental filed in 2018 was between 21.2 ^{o}C to 31.1 ^{o}C. The monthly relative humidity varies from 65% to 92%, with the peak readings occurring in May and June (Essilfie *et al.* 2020).

3.1.3 Soil type and Vegetation

The experimental site is classified as chronic Luvisol and locally as the Bediesi series, with a pH range of 4.0 to 6.5. The location is favourable for the cultivation of root crops, cereals, vegetables, and legumes (Essilfie *et al*,. 2020).

3.2 Experimental design and Treatments

3.2.1 Experimental design

The design of the experiment was 2 × 4 factorial laid in Randomized Complete Block Design (RCBD) with eight treatments and each replicated three times.

3.2.2 Treatments combinations

There were eight treatment combinations as shown in Table 3.1

Table 3.1: Details of Treatments

Treatments	Variety	Weed control regimes
T1	Abontem	Hoeing at 3, 5, 7 weeks
T2	Abontem	Hoeing at 3, 5 weeks
T3	Abontem	Hoeing at 3 weeks
T4	Abontem	No hoeing
T5	Omankwa	Hoeing at 3, 5, 7 weeks
T6	Omankwa	Hoeing at 3, 5 weeks
T7	Omankwa	Hoeing at 3 weeks
T8	Omankwa	No hoeing

3.3 Land Preparation and Field layout

The land was ploughed on August 12, 2022, using a disc plough. The plots were laid out after ploughing, the land was levelled and harrowed. Each experimental plot was lined and pegged and measured 3.20 m × 5 m with 1 m left between replications and 0.50 m left between plots. The total size of the field measured 573.3 m^2.

3.4 Planting Materials and Planting

The planting materials used were "Abontem" and "Omankwa" maize varieties obtained from the Council for Scientific and Industrial Research (CSIR) - Crops Research Institute, Fumesua. The grians' colours are yellow and white respectively. These varieties were chosen because they are early maturing, resistant to disease and are drought tolerant. There were four rows of maize plants on each plot. Each of the experimental plot contained twenty-four plants within each row. Each maize variety was planted at 0.8 m inter row and 0.40 m intra row spacing at 3 seeds per hill. Filling in was done within seven days after seedlings emergence while the rest of the plant stands were thinned out to two plants per stand.

3.5 Agronomic Practices

Weeds were controlled by hand hoeing and depending on the treatment plot, it was hoed at 3, 5, and 7 WAP or 3, and 5 WAP, or only 3 WAP. Weeds were not controlled on the control plots. Periodic visits were paid to the experimental site to monitor the incidence of pest and diseases. Throughout the visits to the site, no disease symptoms was observed as well as pest infestation on the crops.

3.6 Data Collection and Analysis

All vegetative data were taken from the random sampled 5 plants stands, however, the yield components were taken per plant and per plot. The field data were taken on phenology, vegetative growth, yield and yield components. Vegetative growth data were taken on five randomly selected plants per plot from the harvestable area while the yield and yield components from the two middle rows per plot at harvest. The phenological data was taken on percentage crop establishment and days to 50% silking. The vegetative growth data was taken on plant height (cm) and stem diameter (cm). In addition, the yield and yield components data was taken on; number of plants harvested, number of cobs per plant, number of cobs per plot, stover weight per plot (kg), weight of husked maize per plot (kg), seed weight per plot (kg), 100-seed weight (g), harvest index and yield (kg/ha).

3.6.1 Phenology

3.6.1.1 Percentage of crop establishment

The percentage of crop establishment was achieved by counting the number of crops established per plot at three weeks after planting and the percentage estimated.

3.6.1.2 Days to 50% silking

The number of days between the date of sowing and the day on which 50% of the plants generated silk was measured as days to 50% silking per plot.

3.6.2 Vegetative growth

3.6.2.1 Plant height

Five plants were randomly selected and tagged from the two middle rows of each experimental plot. The plants height was measured using a meter rule from soil surface to the last leaf collar toward the apex of the plant. The plant height was taken at the third, fifth and seventh weeks after plant and their means computed.

3.6.2.2 Stem diameter

The stem diameter was measured on the five randomly selected tagged plants within the two middle rows. It was measured from the widest part of the plant about 10 cm from the ground using digital vernier caliper at the third, fifth and seventh weeks after planting and their means computed.

3.6.3 Yield and yield components

3.6.3.1 Number of plants harvested

The total number of crops harvested from the two rows of each of the experimental plot was counted and the mean estimated.

3.6.3.2 Number of Cobs per plant

The number of cobs per plant was obtained by counting the total number of cobs on each of the five tagged plants on each experimental plot and the mean estimated.

3.6.2.3 Number of cobs per plot

The number of cobs per plot was obtained by counting the total number of cobs on all the plant within the two middle rows of each of the experimental plot and the mean estimated.

3.6.3.4 Stover weight per plot (kg)

The entire weight of harvested plants per plot was determined using a spring balance. This included the leaves, stalks and cobs of the harvested plants from the harvestable area and the mean estimated.

3.6.3.5 Husked cob weight per plot (kg)

The husked cob weight per plot was determined by weighing all the harvested husked cobs from the two middle rows using a top pan balance and the mean recorded.

3.6.3.6 Seed weight per plant (g)

The cobs were shelled and the seeds from all the cobs from the five tagged plants within each experimental plot was sun dried to a constant moisture and weighed using electronic weighing scale and the mean estimated.

3.6.3.7 Seed weight per plot (kg)

The cobs were shelled and the seeds from all the cobs from the two rows within each experimental plot was sun dried to a constant moisture and weighed using electronic weighing scale and the mean estimated.

3.6.3.8 100 - seed weight (g)

Hundred seeds were randomly selected from the shelled seed per plot and weighed with electronic weighing scale for each of the experimental plot and the mean recorded.

3.6.3.9 Yield (kg/ha)

The total seed weight per plot for each the varieties were for each experimental plots were used to estimate the yield in kilogram per hectare. After sun drying, the cobs were threshed manually and yield was recorded on per plot basis, and then was converted into kg ha-1 by using the following formula:

$$\text{Grain yield} = \frac{Yield\ per\ plot\ (kg) \times 10000}{Plot\ size\ (m^2)}$$

3.6.3.10 Harvest Index

Harvest index is the ratio of grain yield to the plant biomass produced. It was determined by dividing the grain yield by total biomass yield.

$$\text{Harvest index (HI)} = \frac{Grain\ yield\ (kg)}{Total\ aboveground\ dry\ biomass\ yield\ (kg)} \times 100$$

3.7 Data analysis

The data collected were subjected to Analysis of Variance (ANOVA) using the Statistical Package GENSTAT 12th Edition while significant treatments means were compared using Least Significant Difference (LSD) at 5% level of probability.

CHAPTER FOUR

4.0 RESULTS

4.1 Phenology

4.1.1 Crop establishment

There was no significant differences (P≥0.05) between the varieties, the hoeing regimes and the varieties x the hoeing regimes interactions for crop establishment. (Table 4.1).

Table 4.1: Effects of different weed control regimes on percentage plant establishment of Abontem and Omankwa maize varieties.

Treatment	**Percentage Plant Establishment**
Variety	
Abontem	96.35a
Omankwa	97.40a
LSD (P ≤ 0.05)	**NS**
Hoeing Regimes	
Hoeing at week 3, 5,7	96.53a
Hoeing at week 3, 5	95.83a
Hoeing at week 3	97.57a
No hoeing	97.57a
LSD (P ≤ 0.05)	**NS**
Interaction (Variety x Hoeing Regimes)	
Abontem x Hoeing at week 3, 5, 7	95.14a
Abontem x Hoeing at week 3, 5	95.83a
Abontem x Hoeing at week 3,	96.53a
Abontem x No hoeing	97.92a
Omankwa x Hoeing at week 3, 5, 7	97.92a
Omankwa x Hoeing at week 3, 5	95.83a
Omankwa x Hoeing at week 3,	98.61a
Omankwa x No hoeing	97.22a
LSD (P ≤ 0.05)	**NS**
C V %	**3.30**

Means bearing the same letters within a column are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%; x = interaction.

4.1.2 Days to 50% silking

The Abontem variety recorded early days to 50% silking (59) which was significantly different ($P \leq 0.05$) from the Omankwa variety which showed late days to 50% silking (64) (Figure 4.1a). The weed control regimes was significantly different ($P \leq 0.05$) from the no hoeing treatments (control). However, Hoeing at weeks 3, 5 and 7, weeks 3 and 5, and week 3 showed no significant difference silking though hoeing at weeks 3, 5 and 7 showed early days to silking (56.83). (Figure 4.1b). The Abontem variety x weed control regimes interaction differed significantly ($P \leq 0.05$) from the Abontem x the control interaction. The Omankwa x the weed control regimes interactions also showed significant difference ($P \leq 0.05$) from the Omankwa x the control interaction. However, the varieties x the weed control regimes interactions as well as Abontem variety x the control interactions showed no significant differences ($P \geq 0.05$) (Figure 4.1c).

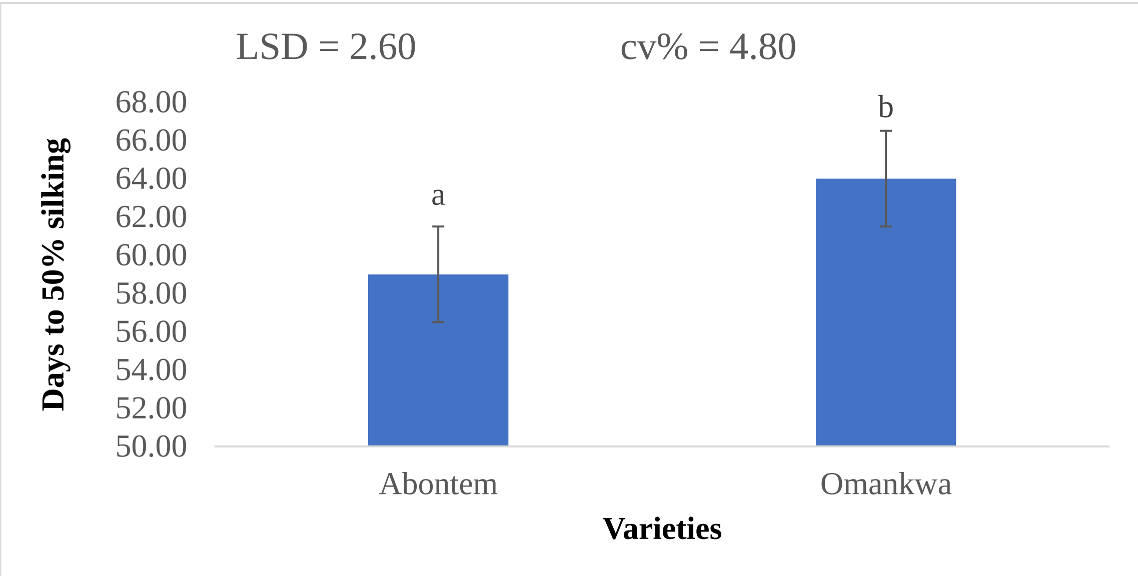

Figure 4.1a: The influence of Abontem and Omankwa varieties to Days 50% silking.

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

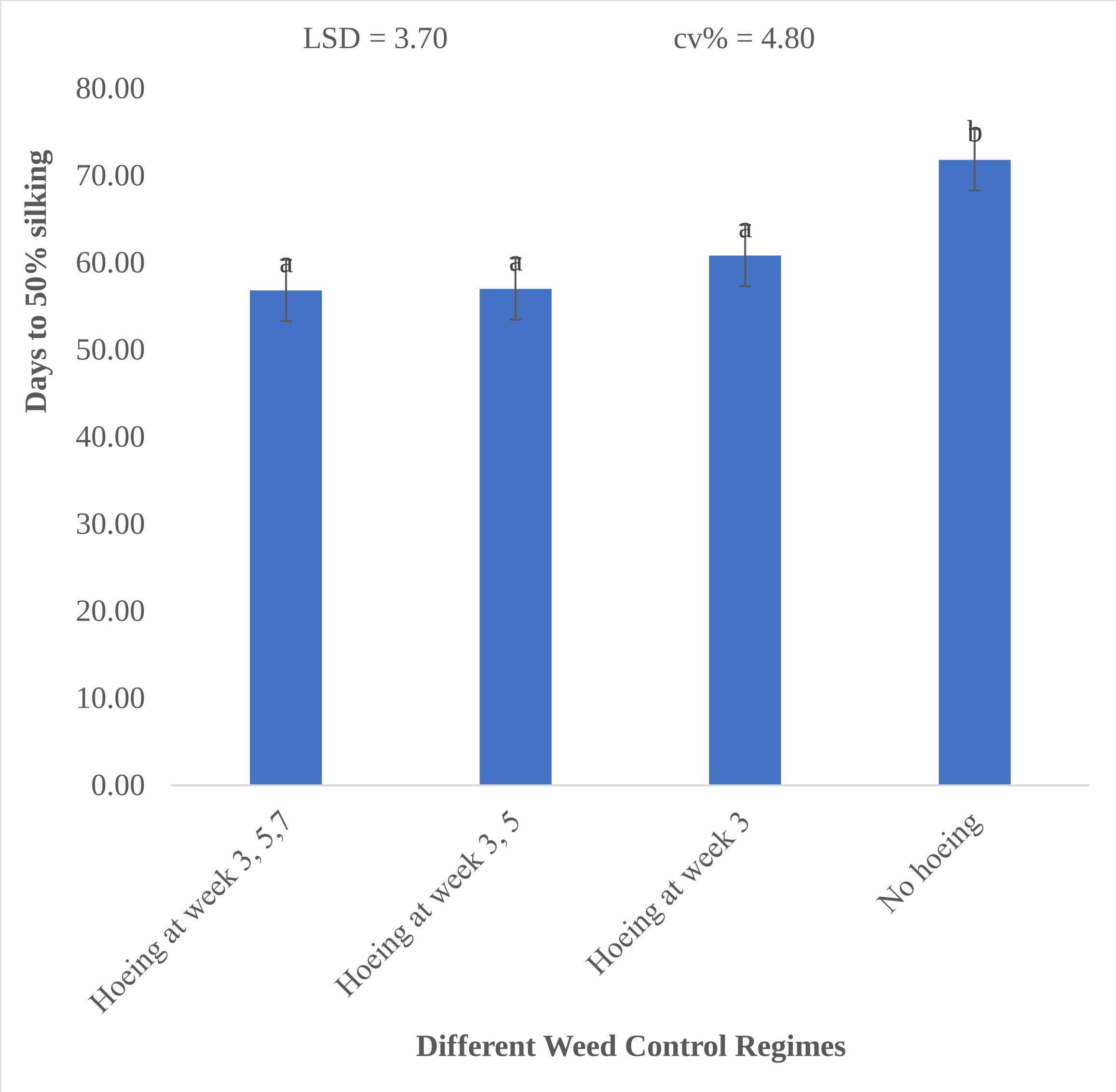

Figure 4.1b: The influence of different Weed Control Regime on Days to 50% silking.

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

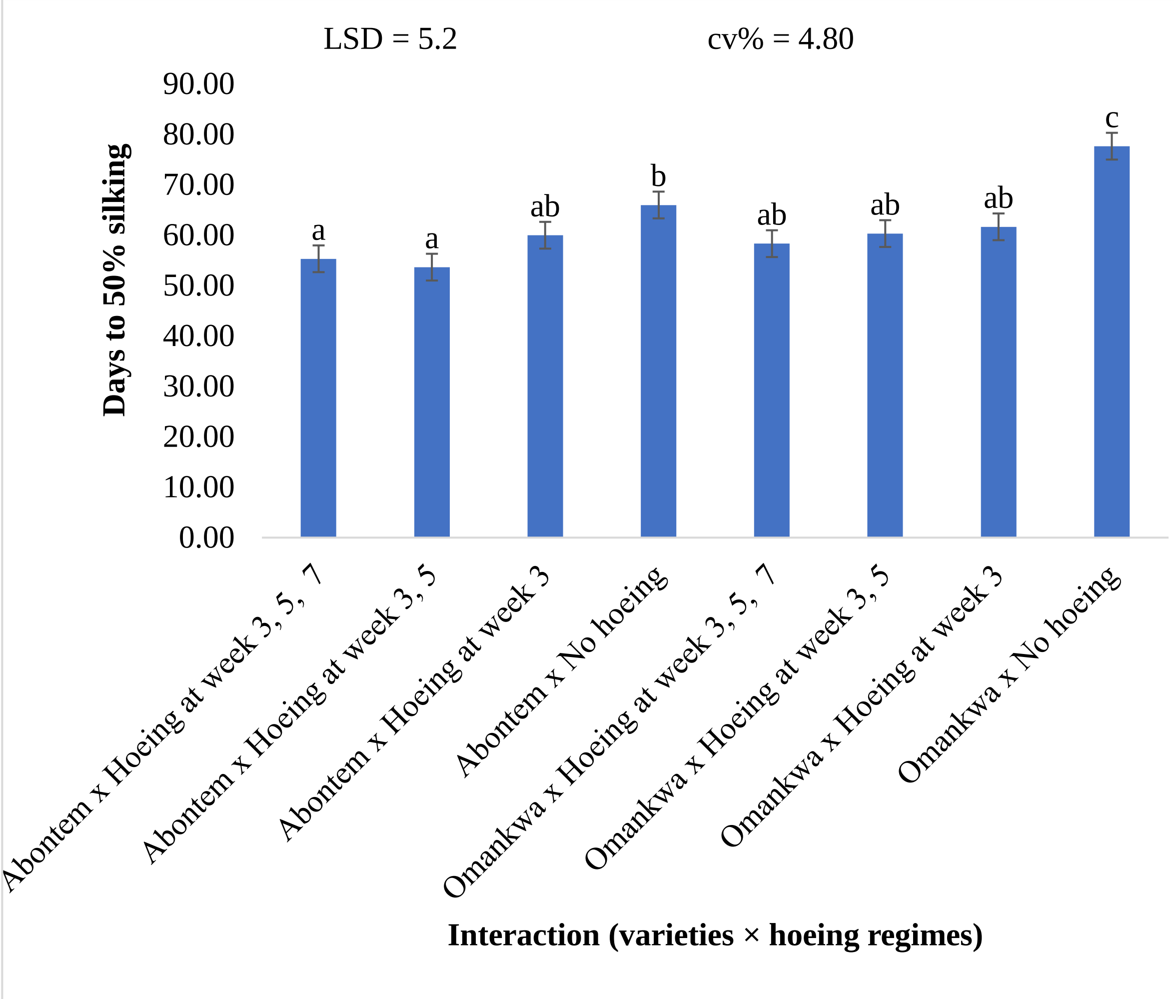

Figure 4.1c: The influence of the interaction between the two maize varieties and Different Weed Control regime on Days to 50% silking.

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

4.2 Vegetative growth

4.2.1 Plant height

There was no significant differences (P≥0.05) between varieties, weed control regimes and varieties x weed control regimes interactions for plant height from 5 to 11 WAP (Table 4.2).

Table 4.2: Effects of Different Weed Control Regimes on the height of Abontem and Omankwa Maize varieties

Treatment	**Plant height (cm)**			
	5 WAP	**7 WAP**	**9 WAP**	**11 WAP**
Variety				
Abontem	15.15a	32.58a	86.80a	119.30a
Omankwa	13.67a	29.44a	83.80a	118.10a
LSD (P ≤ 0.05)	**NS**	**NS**	**NS**	**NS**
Hoeing Regimes				
Hoeing at week 3, 5,7	14.50a	31.92a	99.59a	134.90a
Hoeing at week 3, 5	14.84a	30.60a	80.38a	111.50a
Hoeing at week 3	13.88a	29.53a	78.04a	111.00a
No hoeing	14.42a	31.99a	83.04a	117.20a
LSD (P ≤ 0.05)	**NS**	**NS**	**NS**	**NS**
Interaction (Variety x Hoeing Regimes)				
Abontem x Hoeing at week 3, 5, 7	14.29a	31.90a	99.54a	127.20a
Abontem x Hoeing at week 3, 5	15.79a	32.42a	78.00a	113.00a
Abontem x Hoeing at week 3,	14.44a	30.40a	80.54a	112.80a
Abontem x No hoeing	16.08a	35.60a	88.99a	124.10a
Omankwa x Hoeing at week 3, 5, 7	14.70a	31.95a	99.63a	142.60a
Omankwa x Hoeing at week 3, 5	13.89a	28.78a	82.75a	110.00a
Omankwa x Hoeing at week 3,	13.32a	28.65a	75.55a	109.30a
Omankwa x No hoeing	12.77a	28.38a	77.09a	110.30a
LSD (P ≤ 0.05)	**NS**	**NS**	**NS**	**NS**
C V %	**13.40**	**11.80**	**24.60**	**14.60**

Means bearing the same letters within a column are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%; WAP = Weeks after planting; x = interaction.

4.2.2 Stem diameter

The stem diameter for the varieties showed significant differences (P≤0.05) between them at 7 WAP and 9 WAP. However, there was no significantly different (P≥0.05) between the varieties for stem diameter at 5 WAP and 11 WAP. (Figure 4.3). The weed control regimes revealed significant difference (P≤0.05) from the control at 7 WAP, 9WAP and 11 WAP for stem diameter. However, there was no significant differences between the weed control regimes and the control for stem diameter at 5 WAP. (Table 4.3). There was no significant difference (P≥0.05) between Abontem variety × different weed control regimes and Abontem × control for stem diameter at 5 WAP.

Omankwa × different weed control regimes also did not significantly differ from Omankwa × control interaction at 5WAP for stem diameter. There was a significant difference (P≤0.05) between the Abontem variety x the weed control regimes interactions and the Abontem variety x the control at 7 WAP, 9 WAP and 11 WAP in the stem diameter (Table 4.3).

Table 4.3: Effects of different weed control regimes on the stem diameter of two maize varieties

Treatment	Stem diameter (cm)			
	5 WAP	**7 WAP**	**9 WAP**	**11 WAP**
Variety				
Abontem	0.99a	1.42b	1.53b	1.36a
Omankwa	0.85a	1.28a	1.4a	1.32a
LSD (P ≤ 0.05)	**NS**	**0.87**	**1.12**	**NS**
Hoeing Regimes				
Hoeing at week 3, 5,7	0.95a	1.45b	1.60b	1.48b
Hoeing at week 3, 5	0.98a	1.48b	1.61b	1.50b
Hoeing at week 3	0.89a	1.40b	1.53b	1.43b
No hoeing	0.86a	1.08a	1.12a	0.95a
LSD (P ≤ 0.05)	**NS**	**1.23**	**1.59**	**0.18**
Interaction (Variety x Hoeing Regimes)				
Abontem x Hoeing at week 3, 5, 7	0.99a	1.52c	1.65c	1.50b
Abontem x Hoeing at week 3, 5	1.05a	1.52c	1.64c	1.50b
Abontem x Hoeing at week 3	1.01a	1.51c	1.62c	1.54b
Abontem x No hoeing	0.90a	1.13ab	1.19ab	0.92a
Omankwa x Hoeing at week 3, 5, 7	0.90a	1.39bc	1.55bc	1.47b
Omankwa x Hoeing at week 3, 5	0.91a	1.43c	1.58c	1.50b
Omankwa x Hoeing at week 3,	0.78a	1.28abc	1.44bc	1.33ab
Omankwa x No hoeing	0.82a	1.02a	1.05a	0.98a
LSD (P ≤ 0.05)	**NS**	**1.74**	**2.24**	**0.26**
C V %	**15.80**	**7.30**	**8.70**	**10.90**

Means bearing the same letters within a column are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%; WAP = Weeks after planting; x = interaction.

4.3 Yield and yield components

4.3.1 Number of plants harvested

The varieties, the weed control regimes and the varieties x the weed control regimes interactions showed on significant differences (P≥0.05) for the number of plants harvested (Table 4.4).

4.3.2 Number of cobs per plant

The Omankwa variety recorded the highest number of cobs per plant (1.13) but was not significantly different (P≥0.05) from the Abontem variety (Table 4.4). Hoeing at 3, 5 an7 WAP and 3 and 5 WAP significant differed (P≤0.05) from hoeing at 3 WAP as well as the no hoeing weed control regimes for the number of cobs per plant. Hoeing at week 3 also differed significantly from the no hoeing control check. (Table 4.4). The Abontem variety x hoeing at 3, 5 and 7 WAP and hoeing at 3 and 5 WAP differed significantly (P≤0.05) from the no hoeing weed control check. However, hoeing at week 3 WAP did not significantly differ from the other hoeing regimes as well as no hoeing weed control check for the number of cobs per plant. On the other hand, the Omankwa variety and the different weed control interaction revealed significant difference (P≤0.05) from the no hoeing control check. The varieties and the weed control interaction did not show any significant differences. (Table 4.4).

4.3.3 Number of cobs per plot

The Omankwa variety recorded the highest number of cobs per plot (23.50) but was not significantly different (P≥0.05) from the Abontem variety (Table 4.4). There was significant differences (P≤0.05) between the weed control regimes and the control for the number of cobs per plot. Although hoeing at week 3, 5 and 7 gave the highest number of cobs per plot, there was no significant differences between the weed control regimes (Table 4.4). The varieties x the weed control regimes interactions and the varieties x the control interaction revealed significant differences ($P \leq 0.05$) between them for the number of cobs per plot. There was no significant differences between the varieties x the weed control regimes interactions for the number of cobs per plot (Table 4.4).

Table 4.4: Effects of different weed control regimes on Yield components of two maize varieties

Treatment	Number of Plants harvested	Number of ear per plant	Number of ear per plot
Variety			
Abontem	36.58a	3.04a	23.50a
Omankwa	37.08a	3.38a	23.33a
LSD (P ≤ 0.05)	**NS**	**NS**	**NS**
Hoeing Regimes			
Hoeing at week 3, 5,7	35.83a	4.25b	29.83b
Hoeing at week 3, 5	38.17a	4.33b	30.17b
Hoeing at week 3	40.00a	3.67b	27.00b
No hoeing	33.33a	0.58a	6.67a
LSD (P ≤ 0.05)	**NS**	**0.87**	**4.91**
Interaction (Variety x Hoeing Regimes)			
Abontem x Hoeing at week 3, 5, 7	35.33a	4.17b	27.00b
Abontem x Hoeing at week 3, 5	39.33a	4.17b	33.00b
Abontem x Hoeing at week 3,	37.67a	3.50b	25.33b
Abontem x No hoeing	34.00a	0.33a	8.67a
Omankwa x Hoeing at week 3, 5, 7	36.33a	4.33b	32.67b
Omankwa x Hoeing at week 3, 5	37.00a	4.50b	27.33b
Omankwa x Hoeing at week 3,	42.33a	3.83b	28.67b
Omankwa x No hoeing	32.67a	0.83a	4.67a
LSD (P ≤ 0.05)	**NS**	**1.24**	**6.94**
C V %	**12.70**	**22.00**	**16.90**

Means bearing the same letters within a column are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%; x = interaction.

4.3.4 Stover weight per plot (kg)

The Omankwa variety recorded a higher mean value for Stover weight (3.66 kg) which was significantly different (P≤0.05) from the Abontem variety (Figure 4.2a). There was significant difference (P≤0.05) between the weed control regimes and the control for Stover weight. Hoeing at 3 and 5 WAP showed the highest Stover weight per plot (4.54 kg) however there was no significant differences between the weed control regimes (Figure 4.2b). There was significant difference (P≤0.05) between the varieties x the hoeing at week 3 and 5 interaction, the Omankwa x hoeing at 3, 5 and 7 WAP and the varieties x the control interaction for Stover weight. The Abontem x hoeing at 3, 5 and 7 WAP, and hoeing at 3 WAP, Omankwa x hoeing at 3 WAP interactions and the varieties x control interactions showed no significant differences (Figure 4.2c).

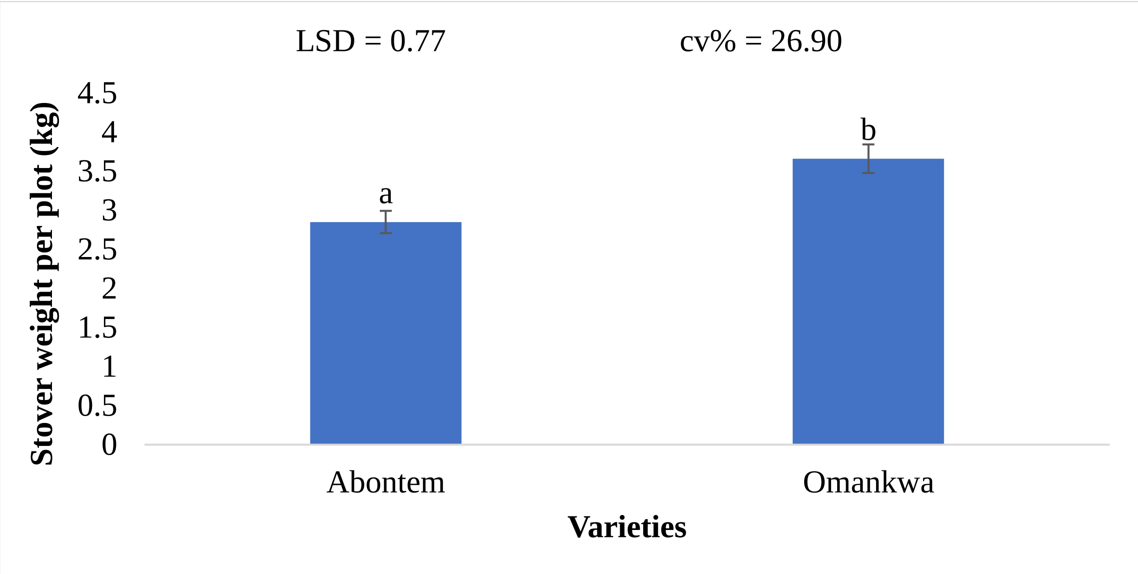

Figure 4.2a: Influence of the two maize varieties on Stover weight

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

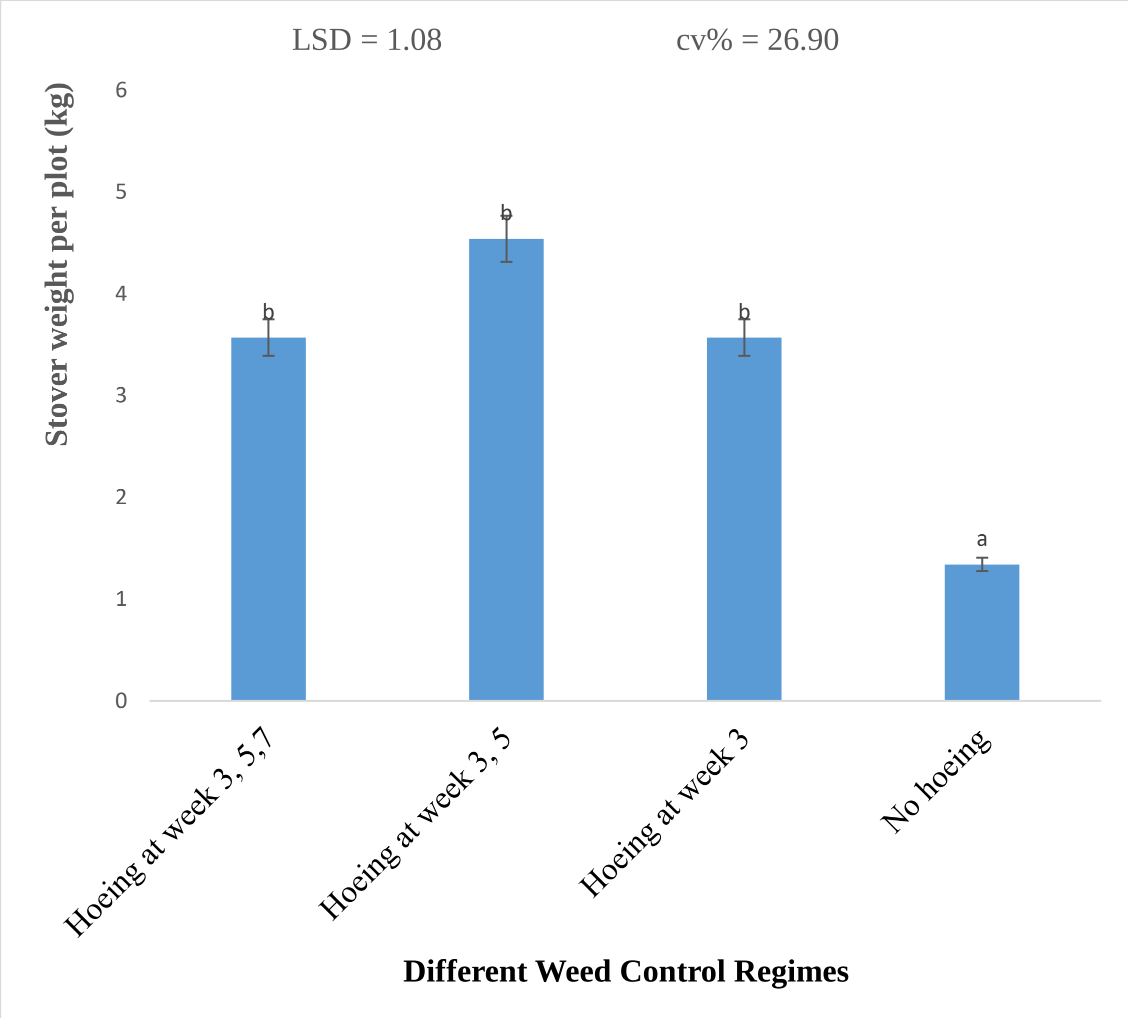

Figure 4.2b: Stover weight of maize as influenced by Different Weed Control Regimes

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

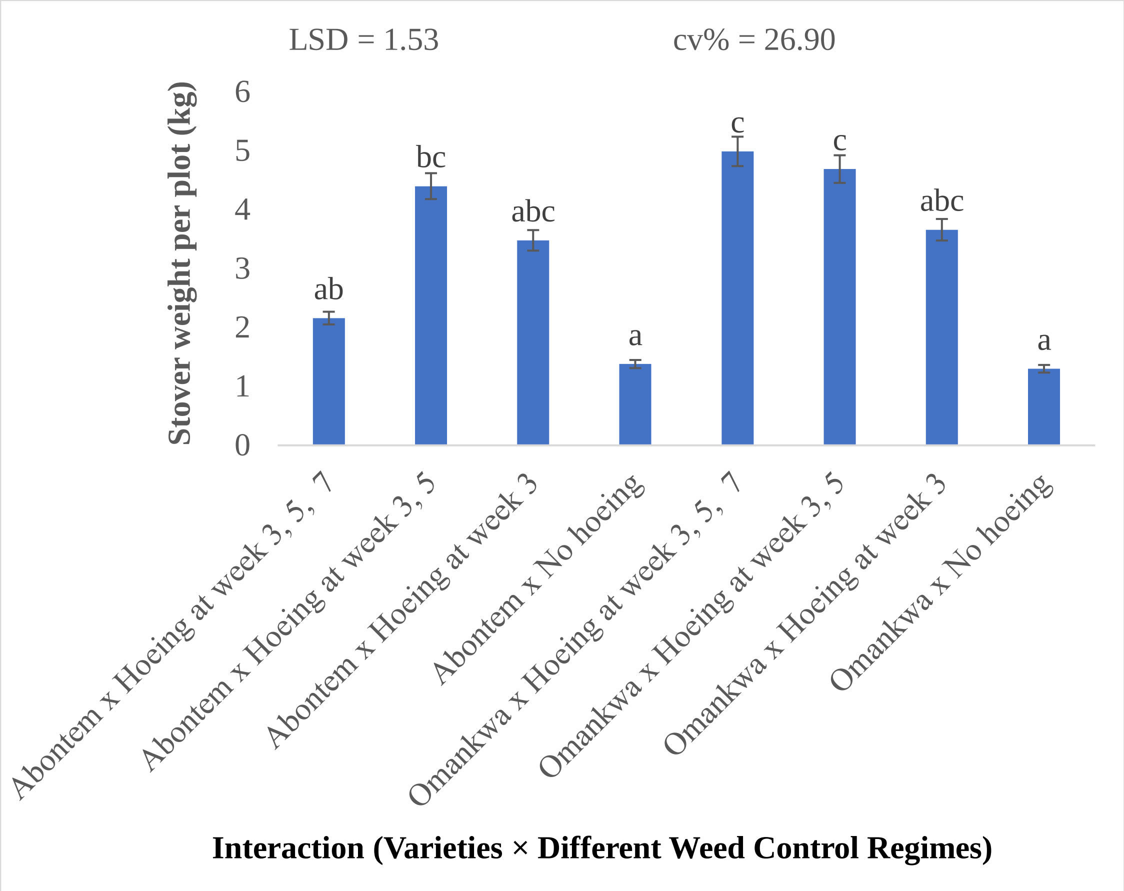

Figure 4.2c: Stover weight of Abontem and Omankwa maize Varieties as influenced by Different Weed Control Regimes

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

4.3.5 Husked cob weight per plot (kg)

There was no significant difference (P≥0.05) between the varieties though the Omankwa varieties had the higher value of weight of husked maize per plot (1.21 kg). (Figure 4.3a) There was significant difference (P≤0.05) between hoeing at 3 and 5 WAP and the control for the weight of husked ear per plot. However, there was no significant difference between the weed control regimes. Also, hoeing at 3 WAP did not differ significantly from the control (Figure 4.6b). The Omankwa variety x hoeing at 3, 5 and 7 WAP interaction was significantly different (P≤0.05) from the varieties x control interactions for weight of husked ear per plot. However, there was no significant differences (P≥0.05) between the varieties x the weed control regimes interactions for weight of husked ear per plot. In addition, the Abontem variety x hoeing at 3, 5 and 7 WAP, and hoeing at 3 WAP, and the Omankwa variety x hoeing at 3 WAP interaction showed no significant difference from the varieties x the control interaction for the weight of husked ear per plot (Figure 4.3c).

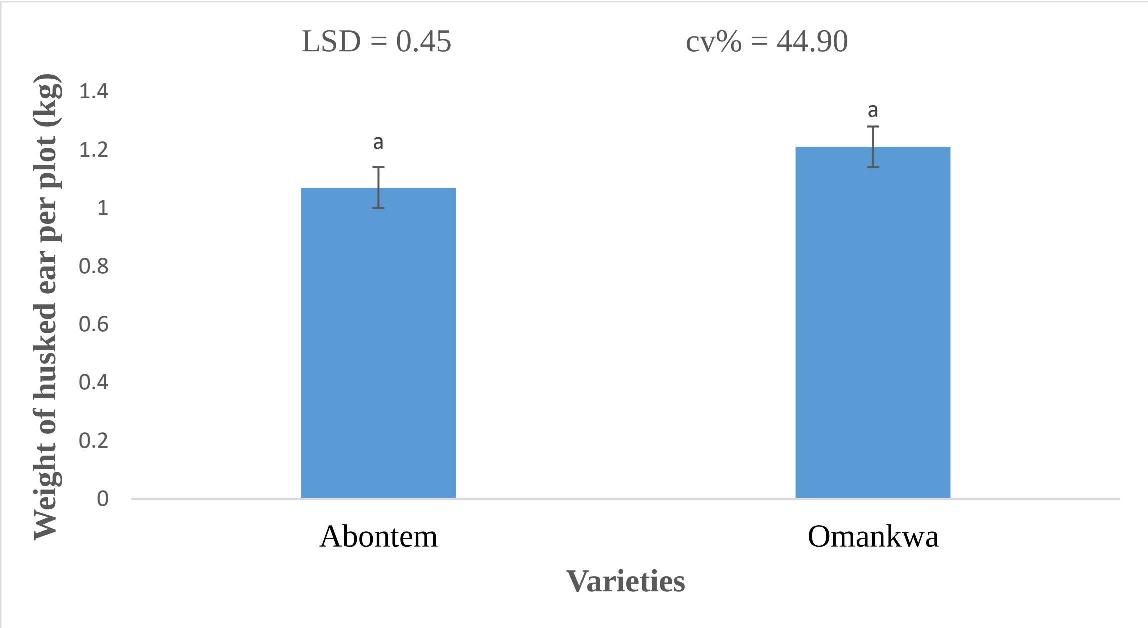

Figure 4.3a: Influence of Abontem and Omankwa maize Varieties on Husked cob weight per Plot

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

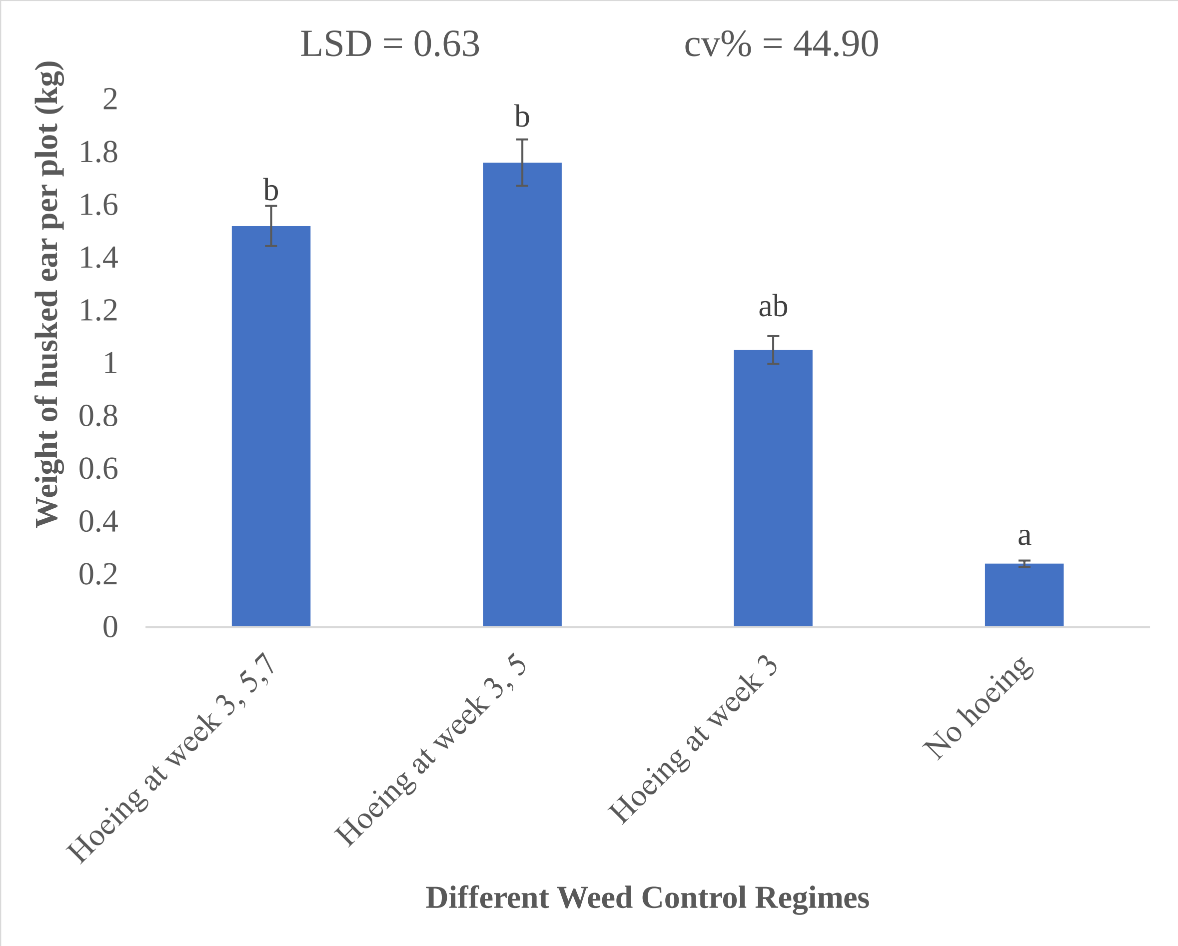

Figure 4.3b: Effects of Different Weed Control Regimes on the Husked cob Weight per Plot

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

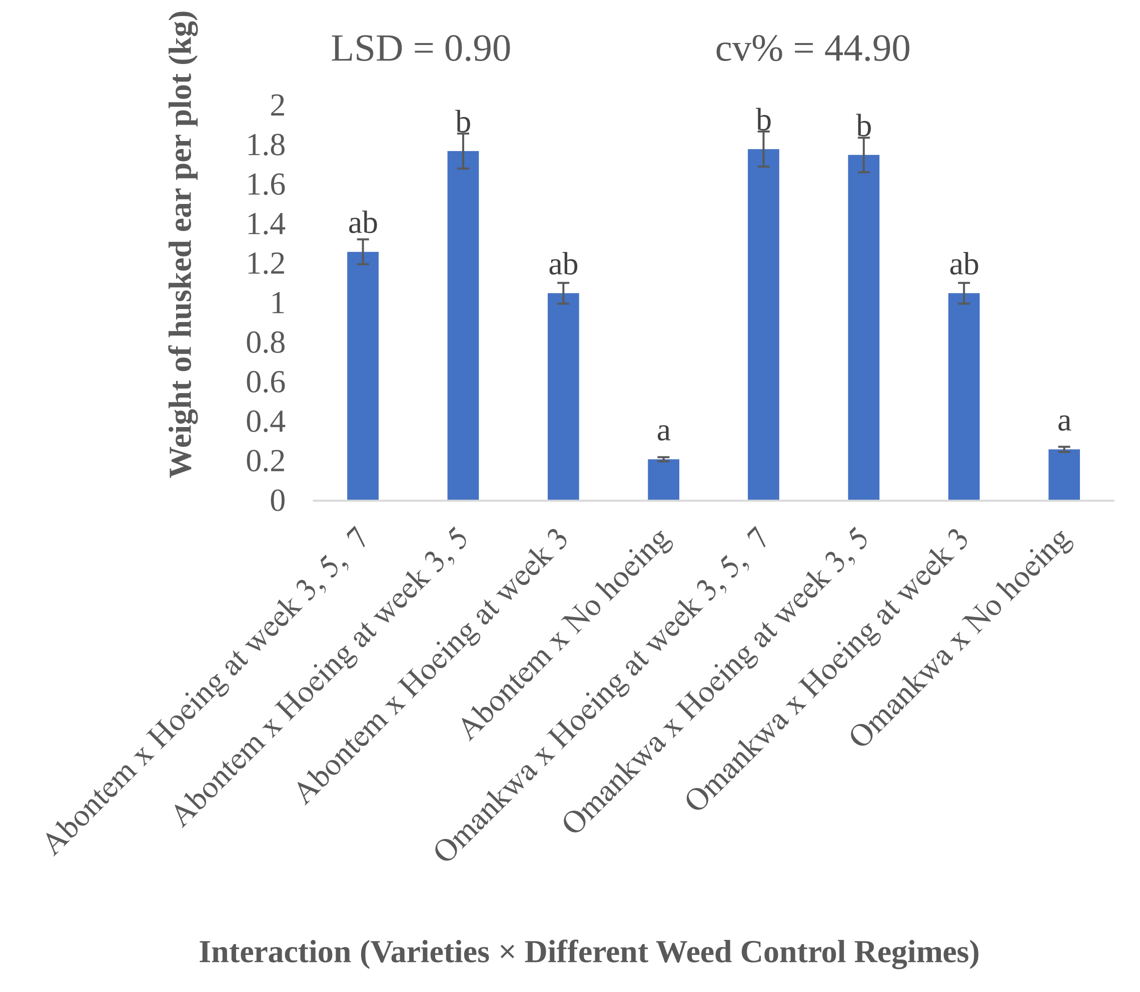

Figure 4.3c: Effect of interaction (varieties × weed control regimes) on the of husked cob weight per plot.

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

4.3.6 Seed weight per plant (g)

The Omankwa variety showed a higher value of seed weight per plant (246.00 g) but was not significantly different (P≥0.05) from the Abontem variety which had the lower mean value (175.00 g) (Table 4.5).

Hoeing at 3, 5 and 7 WAP was significant difference (P≤.0.05) from hoeing at 3 WAP, and the control. However, hoeing at 3 WAP showed no significant difference from hoeing at 3 and 5 WAP and the control for seed weight per plant. (Table 4.5). The Omankwa variety x hoeing at 3, 5 and 7 WAP interaction recorded the highest value (453.30 g) of the seed weight per plant which showed a significant difference (P≤0.05) from the interaction between Omankwa variety x hoeing at 3 WAP, as well as the varieties x the control interactions. However, the Abontem variety x weed control regimes interactions did not show significant difference from the Omankwa variety x the weed control regimes interaction and the varieties x control interactions for seed weight per plant. (Table 4.5).

4.3.7 Seed weight per Plot (kg)

There was no significant difference (P≥0.05) between the varieties though the Omankwa variety recorded a higher value (0.80 kg) for the seed weight per plot (Table 4.5). There was significant difference (P≤0.05) between the weed control regimes and the control for seed weight per plot. Hoeing at 3 and 5 WAP showed the highest seed weight per plot (1.11 kg) however there was no significant differences between the weed control regimes (Table 4.5). The Omankwa variety x hoeing at 3, 5 and 7 interaction showed significant difference (P≤0.05) from the varieties x the control interaction. However, there was no significant difference within the weed control regimes. Again, the Abontem variety x hoeing at 3, 5 and WAP, hoeing at 3 WAP, Omankwa variety x hoeing at 3 WAP, and the varieties x the control interactions did not revealed any significant differences for seed weight per plot (Table 4.5).

4.3.8 100 - seed weight (g)

The 100 - seed weight of the varieties showed no significant difference ($P \geq 0.05$) though the Omankwa variety recorded the higher mean value (16.22 g) (Table 4.5). Hoeing at 3 and 5 WAP recorded the highest value (19.05 g) for 100 seed weight which showed significant differences ($P \leq 0.05$) from the control. However, there was no significant difference between the weed control regimes for 100 seed weight. Hoeing at 3 WAP also revealed no significant difference from the control. (Table 4.5). There was significant difference ($P \leq 0.05$) between the Omankwa variety x hoeing at 3 and 5 WAP interaction and the Omankwa x the control interaction for 100 seed weight. The varieties x the weed control regimes interaction showed no significant difference between them. In addition, there was no significant difference between the Abontem variety x the control interaction and the varieties x the weed control regimes interactions. (Table 4.5).

4.3.9 Yield (kg/ha)

There was no significant difference ($P \geq 0.05$) between the varieties, though the Abontem variety had a higher yield (422.06 kg/ha) whiles Omankwa had a lower yield (397.81 kg/ha) (Table 4.5). There was significant difference ($P \leq 0.05$) between the weed control regimes and the control. Hoeing at 3 and 5 WAP recorded the highest yield (693.90 kg/ha) but there was no significant difference among the weed control regimes (Table 4.5). The Omankwa variety x hoeing at 3, 5 and 7 interaction showed significant difference ($P \leq 0.05$) from the varieties x the control interaction for yield. However, there was no significant difference within varieties x the weed control regimes interaction. Again, the Abontem variety x hoeing at 3, and 5 WAP, hoeing at 3 WAP interaction, Omankwa variety x hoeing at 3 WAP interaction, and the varieties x the control interactions did not reveal any significant differences for yield in kilograms per hectare (Table 4.5).

Table 4.5: Effects of Different Weed Control Regimes on the Yield (kg/ha) and yield components of Abontem and Omankwa Maize Varieties

Treatment	Seed weight per plant (g)	Seed weight per plot (kg)	100-seed weight (g)	Yield (kg/ha)
Variety				
Abontem	175.00a	0.68a	15.23a	422.06a
Omankwa	246.00a	0.80a	16.22a	397.81a
LSD (P ≤ 0.05)	**NS**	**NS**	**NS**	**NS**
Hoeing Regimes				
Hoeing at week 3, 5,7	353.30c	1.07b	18.13b	668.40b
Hoeing at week 3, 5	318.50bc	1.11b	19.05b	693.90b
Hoeing at week 3	158.20ab	0.63b	15.02ab	392.50b
No hoeing	11.80a	0.13a	10.71a	83.80a
LSD (P ≤ 0.05)	**130.70**	**0.36**	**4.40**	**226.537**
Interaction (Variety x Hoeing Regimes)				
Abontem x Hoeing at week 3, 5, 7	253.40abc	0.80ab	16.13ab	500.8.0ab
Abontem x Hoeing at week 3, 5	269.70abc	1.17b	17.20ab	733.6.0b
Abontem x Hoeing at week 3,	170.60abc	0.6ab	14.76ab	373.00ab
Abontem x No hoeing	4.30a	0.13a	12.83ab	80.80a
Omankwa x Hoeing at week 3, 5, 7	453.30c	1.34b	20.13b	836.10b
Omankwa x Hoeing at week 3, 5	367.30bc	1.05b	20.89b	654.20b
Omankwa x Hoeing at week 3,	145.70ab	0.66ab	15.27ab	412.00ab
Omankwa x No hoeing	19.20a	0.14a	8.59a	86.80a
LSD (P ≤ 0.05)	**184.80**	**0.51**	**6.22**	**320.372**
C V %	**50.10**	**39.80**	**22.60**	**39.80**

Means bearing the same letters within a column are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%; x = interaction.

4.3.10 Harvest Index

There was no significant difference ($P \geq 0.05$) between the varieties for harvest index though the Abontem variety revealed the higher value (0.23). (Figure 4.4a). Hoeing at 3, 5 and 7 WAP showed significant difference ($P \leq 0.05$) from hoeing at 3 WAP and the control but did not significantly differ from hoeing at 3 and 5 WAP. Hoeing at 3 and 5 WAP also showed significant difference ($P \leq 0.05$) from the control but was not significant difference from the other weed control regimes. Hoeing at 3 WAP was not significantly different from the control (Figure 4.4b). The Abontem x hoeing at 3, 5 and 7 WAP interaction revealed significant difference from the Abontem variety x hoeing at week 3 interaction, Omankwa variety x hoeing at 3 WAP interaction and the varieties x control interaction. However aside the Abontem x hoeing at 3, 5 and 7 WAP interaction all the other interactions showed no significant difference. (Figure 4.4c).

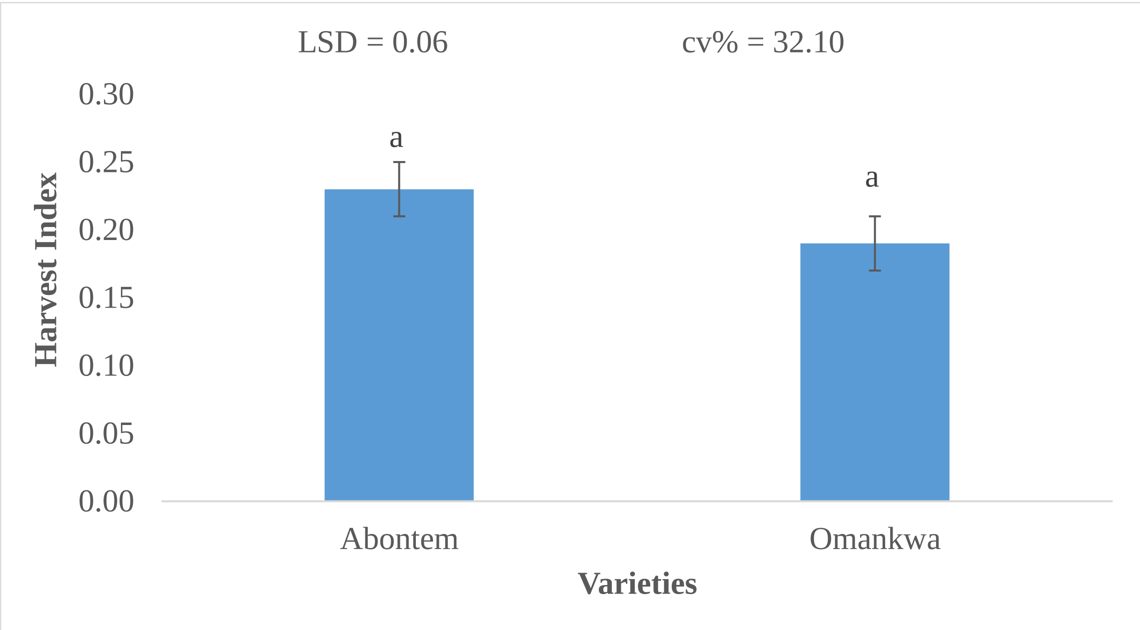

Figure 4.4a: Influence of Abontem and Omankwa maize Varieties on Harvest Index

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

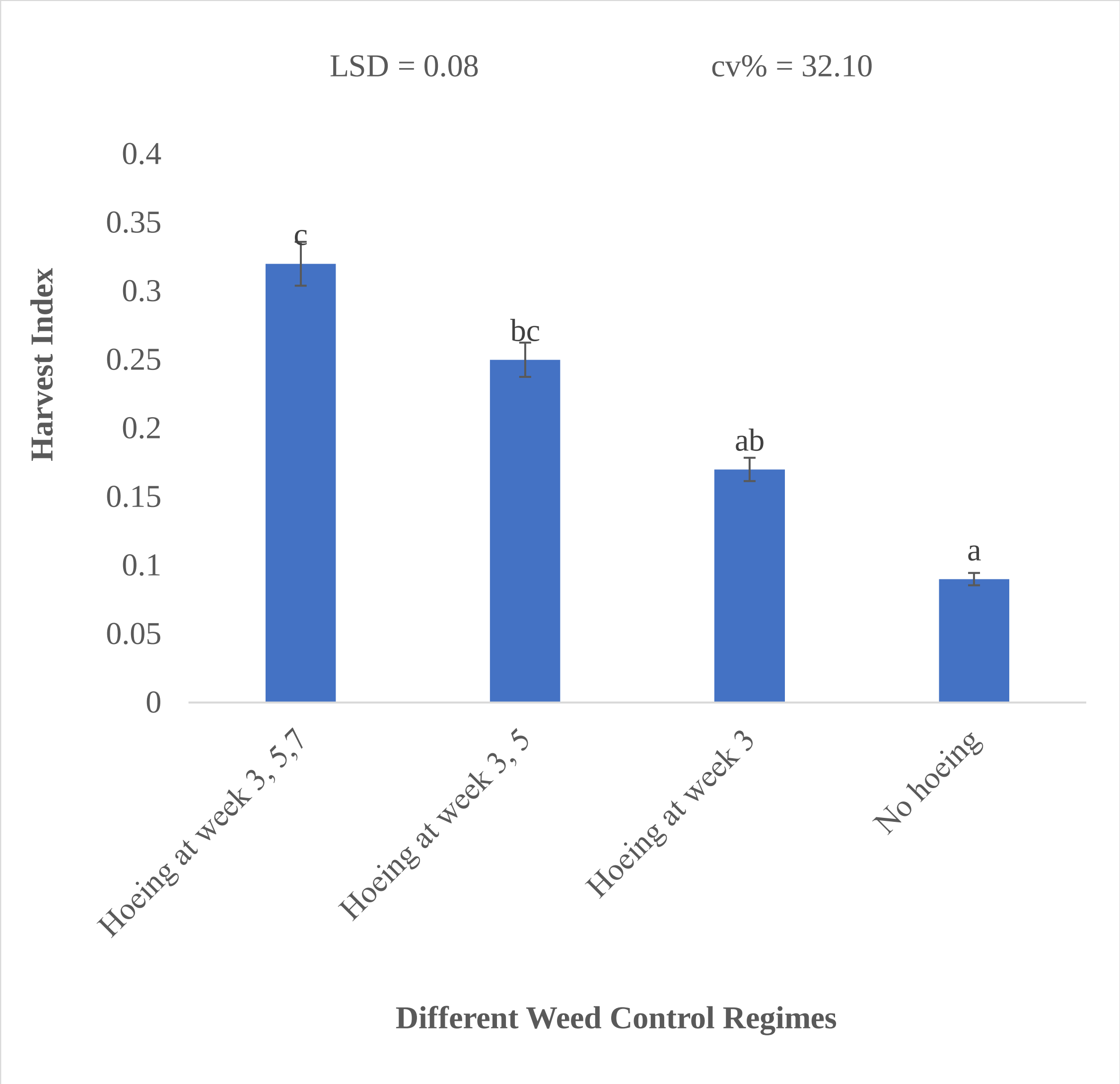

Figure 4.4b: Effects of Different Weed Control Regimes on Harvest Index

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

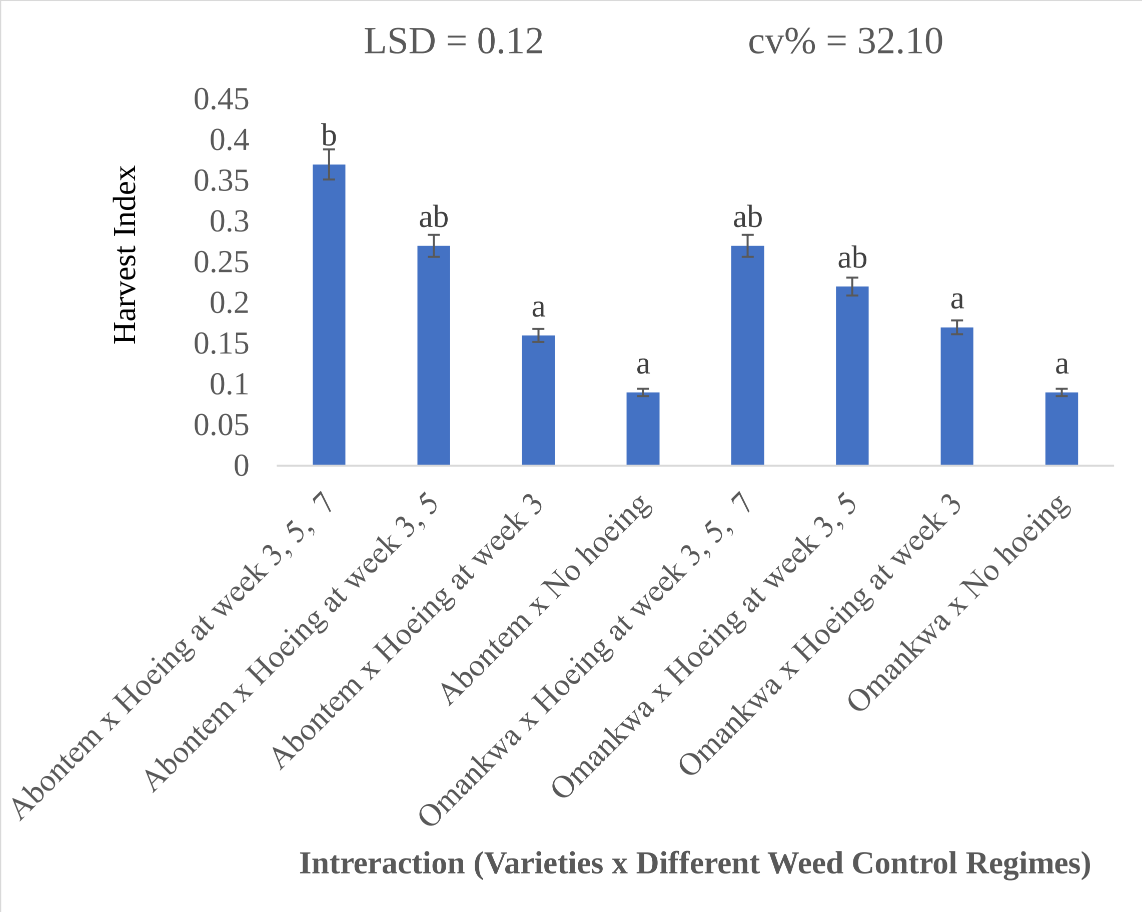

Figure 4.4c: Effect of interaction (varieties × weed control regimes) on harvest index.

Note: *Means bearing the same letters on the bar are not significantly different at 5% level of significance (NS); CV = coefficient of variation; LSD = Least significant difference at 5%.*

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effects of different weed control regimes on Phenology of Maize

The percentage plant establishment did not significantly vary between Abontem and Omankwa, the different hoeing regimes and the interaction between Abontem and Omankwa × different hoeing regimes interaction. This may be that treatments had similar effects on varieties and also the outcome of the varieties seed quality, planting depth, and the hoeing regimes. High quality seed increases the rate of plant establishment as well as the planting depth and timely weed control affects the germination maize (Amini *et al.*, 2017). The Abontem recorded early days to 50% silking (59) which was significantly different ($P \leq 0.05$) from Omankwa which showed late days to 50% silking (64). This resulted from the differences in the varieties silking dates. This agrees with a publication by CSIR, (2019) which indicated that Abontem variety has early days to silking compared to the Omankwa variety.

The weed control regimes considerably differed from the no hoeing treatments (control). This was as a result of the effect of the competition between the plants and the weeds. The different hoeing regimes had a decreased competition for resources and hence increased the crops assess to growth resources such as soil water, nutrient and sunlight. Weed control was most sensitive before and during maize silking. During silking, the worst levels of late-season weed management resulted in a 61% yield reduction (Landau *et al.*, 2021). The Abontem variety × weed control regimes interaction differed significantly ($P \leq 0.05$) from the Abontem × control interaction. The Omankwa variety × weed control regimes interactions also varied significantly from the Omankwa variety × control interaction. This was due to reduction of competition for nutrients and other growth resources because weeds were controlled which enhanced the reproductive growth of the crops. The control plot without hoeing increased competition for growth resources which delayed reproductive growth of the Abontem and Omankwa varieties. Two-hand weeding resulted in early days to tasseling and silking, which statistically varied from the control (Bist *et al.,* 2023).

5.2 Effect of different weed control regimes on Vegetative growth of maize

Plant height was not significantly affected by weed control regimes. This could be that the treatments were similar and did not exhibit significant differences. Weeds and crops competed for sunlight and space in the weedy plots, which caused the plants to grow at equal height with no obvious differences in plant height. This confirms Osman *et al.* (2020), that the tallest rice plant was found in hand weeding at 15 & 30 DAT (95.56 cm) and shortest plant was observed in no weeding (91.78 cm) which differed non-significantly. Weed control practices had a considerable impact on maize plant height. At 75 DAS, two hand weed had significantly greater plant height than other weed control practices and the weedy check (Bist *et al.,* 2023).

The stem diameter did not differ significantly between Abontem and Omankwa varieties at 5 and 11 WAP. The mean values of the stem diameter for Abontem however significantly differed from Omankwa variety at 7 and 9 WAP. The stem diameter for different weed control regimes did not significantly vary from the control at 5 WAP. The stem diameter for the different weed control regimes significantly differed from the control at 7, 9 and 11 WAP. The highest mean values (0.98 cm), (1.48 cm), (1.61 cm) and (1.50 cm) for 5, 7, 9 and 11 WAP respectively was recorded at hoeing at 3 and 5 WAP. This was because different hoeing regimes made nutrients readily available to the maize plants thereby increasing its vegetative growth whiles the no hoeing control plots caused the plants to increase their competition for growth resources. This in agreement with a study by Janmohammadi *et al.* (2017) who revealed that the stem diameter measurements on dragonhead plants with no weeding had the thinnest stems, and one hand weeding might enhance stem diameter by up to 16% above the weedy check condition. However, there was no significant difference between the other weed control techniques. At 5 WAP, the stem diameters revealed no significant variations between the two maize varieties × weed control regimes interactions, and the two maize varieties × the control interactions.

The Abontem × different weed control regimes interactions varied significantly from Abontem × the control interaction in stem diameter at 7, 9 and 11 WAP. Again, Omankwa × different weed control regimes substantially different from the Omankwa × control in stem diameter at 7, 9 and 11 WAP. However, Omankwa × hoeing at 3 WAP did not vary significantly from Omankwa × control interaction 11 WAP. This may result from how the two maize varieties reacted to the competition for growth resources such as soil nutrient, sunlight and soil moisture in the different weed control plots as well as the control plot. This is supported by Soleymani *et al*. (2016) who indicated that pre-emergence chemical application and two mechanical hand weeding increased stem diameter in maize.

5.3 Effect of different weed control regimes on Yield and Yield components of maize.

There was no significant variation between Abontem and Omankwa, different weed control regimes and the interaction between Abontem and Omankwa × different weed control regimes in number of plants harvested. This results might be due to the ability of the Abontem and Omankwa maize varieties to compete with weeds for growth resources.

This contradicts Ullah *et al.* (2023) who recorded higher number of plants harvested in one hand weed + mulching treatment which differed significantly from the unweeded control treatment. However, the percentage of plant establishment and the variety's ability to compete with weeds had an impact on the number of harvested plants. This is in line with Blake *et al.* (2017) who indicated that the number of established plants and seedling vigour will influence the crop's ability to compete against weeds, which will eventually decide both the number of harvested plants and the potential yield.

Abontem expressed no significant variance from Omankwa for number of cobs per plant. The different hoeing regimes differed significantly from the control with hoeing at 3, 5 and 7 WAP producing the highest number of cob per plant (1.67). This study agrees with Ullah *et al.* (2023). Abontem × different hoeing regimes interactions differed significantly from the Abontem × the control interactions for the number of cob per plot as well as the number of ear per plant. Omankwa × different hoeing regimes differed significantly from the Omankwa × the control interactions for the number of cob per plot as well as the number of ear per plant. The significant difference in number of cobs per plant under these treatments might be attributed to the periodic eradication of weeds by manual hoeing at 3, 5, and 7 WAP, which could have maintained good soil fertility and moisture status. These findings are consistent with those reported by Barad *et al.* (2016).

The number of cobs per plot for Abontem and Omankwa showed no statistical variations. The maximum number of cobs per plot (30.17) was produced by hoeing at 3 and 5 WAP, which differed significantly from the control. The interactions between Abontem and Omankwa × different hoeing regimes were statistically different from those between Abontem and Omankwa × control. The maximum number of cobs per plot was produced by Abontem × hoeing at 3 and 5 WAP interaction, whereas the lowest number of cobs per plot was in Omankwa × no hoeing interaction. The statistical variance in the number of cobs per plot under these treatments might be related to the periodic eradication of weeds by manual hoeing, which could have maintained excellent soil fertility, moisture, and access to sunlight by withdrawing less plant nutrients and moisture by weeds. This current study is in line with (Shrestha *et al.* 2021).

The weight of Stover produced per plot varied significantly between Abontem and Omankwa maize varieties. The Omankwa variety weighed (3.66 kg) whilst Abontem variety weighed (2.85 kg). The weight of the Stover under the different weed management strategies varied significantly from the control. Hoeing at 3 and 5 WAP resulted in the heaviest weight of Stover (4.54 kg), whereas no hoeing resulted in the least weight of Stover (1.34 kg). This could be due to decreased weed competition with the hoeing treatments at different periods, which allowed maize plants to accumulate more photosynthates for plant growth.

This is confirmed by Imoloame *et al.* (2017), who indicated that weeding twice at 3 and 6 weeks after sowing in maize considerably decreased weed competition, making resources easily accessible to the plants, which improved dry matter accumulation. The Stover weight per plot from the study was highest (499 kg) for Omankwa × hoeing at 3, 5 and 7 WAP interaction which considerably varied from the Abontem × hoeing at 3, 5 and 7 WAP interaction. This was in agreement with Akter *et al.* (2016), that two hand hoeing at 20 and 40 days after planting on soybeans produced the highest Stover weight, which was statistically different from the other weed management techniques he applied in his study. Abontem and Omankwa did not differ significantly for husked cob per weight plot. The husked cob weight per plot was highest in hoeing at 3 and 5 WAP (1.76 kg) which differed significantly from the control (0.24 kg). However, hoeing at 3 WAP did not significantly differ from the no hoeing. The significant difference could be due to increased competition for nutrients other growth resources between the plant and the weeds in the control plot, whereas the expressive difference resulted from the reduction of competition for growth resources within the hoed plots. According to Rajeshkumar *et al.* (2017), rotary hoeing twice (15 and 35 days after sowing) reduced weed density higher than other weed control methods used in an experiment conducted. The Abontem × hoeing at 3 and 5 WAP significantly varied from Abontem × control interaction. The Omankwa × hoeing at 3, 5 and 7 WAP interaction produced the highest weight of husked ear per plot (1.78 kg), which was significantly different from the Omankwa × control interaction (0.26 kg). The Abontem × hoeing at 3, 5 and 7 WAP interaction, as well as the Abontem and Omankwa × hoeing at 3 WAP interaction, showed no significant differences from the two maize varieties × control interactions.

Hand weeding as a method of control weeds produced the highest husked cob weight which differed significantly from the control weedy plot which partially supports this study (Kumar & Rana, 2022). The seed weight per plant was greater in Omankwa (246 g) than Abontem (175 g), although there was no significant differences between the varieties. Hoeing at 3, 5, and 7 WAP had the greatest seed weight per plant (353.30 g) which differed significantly from hoeing at 3 WAP and the control. This could be due to intense competition between crops and weeds for nutrients, water, light, and air in the 3 WAP and control plots. The Omankwa × hoeing at 3, 5 and 7 WAP interaction had the greatest seed weight per plant (453.30 g). The different hoeing regimes and the control did not show significant differences in the Abontem variety. However, the Abontem × hoeing at 3 and

5 WAP interaction gave the highest yield (269.70 g) whiles the lowest value (4.30 g) was found in Abontem × no hoeing interaction. Again, the Omankwa × hoeing at 3 WAP interaction did not differ significantly from the two maize varieties × control interactions. This might be due to how the maize varieties responded to the varied hoeing regimes. This is in agreement with the findings by Samoy-Pascual *et al.* (2020), that two hand weeding in rice produced highest grain weight in rice compared to no weeding control.

The seed weight per plot for Abontem and Omankwa varieties did not differ significantly although Omankwa variety had the highest value (0.80 kg). The seed weight per plot for the different hoeing regimes differed significantly from the control. Hoeing at 3 and 5 WAP gave the highest seed weight per plot (1.11kg) although did not significantly differ from the other hoeing regimes. The Omankwa × hoeing at 3, 5 and 7 WAP interaction yielded the highest seed weight per plot (1.34 kg) and showed significant difference from the varieties and the control interactions. The Abontem × hoeing at 3, 5 and 7 WAP as well as hoeing at 3 WAP and the Omankwa variety and hoeing at 3 WAP were not significantly different from the varieties and the control interaction. This confirms the report by Imoloame (2014) that pre-emergence herbicides application + two hand hoeing produced the highest seed weight soyabean which statistically differed from the no hoeing control.

Though Omankwa recorded the highest 100-seed weight per plot (16.22 g), it did not differ significantly from other treatments. This is in line with the findings of Samoy-Pascual *et al.* (2020), who established that the Omankwa produced higher seed weight per plot but was identical to Abontem. There was no appreciable difference between the weed management strategies and the control. The greatest value for 100-seed weight was recorded by hoeing at 3 and 5 WAP (19.05 g) and the least was the control (10.71). This was due to the fact that hoeing the fields at 3, 5, and 7 weeks after planting made the crops' vital growth resources available. However, hoeing at 3 WAP did not vary significantly from the control. This may be due to competition of the plants with the weeds for growth resources in hoeing at 3 WAP and the control plots. Osman *et al.* (2020) observed that the maximum grain production was obtained by manual weeding, which statistically differed from no weeding condition thereby lowering the crop's yield and weight.

Osman *et al.* (2020) further observed that, two rice varieties had hand weeding yield the highest weight of one-thousand grains, and no weeding yield the lowest weight of a thousand grains, which was significantly different. This confirms the current study results on 100-seed weight, which indicated that there was little to no difference between the Omankwa and the control, but that there was a considerable difference between the varieties and weed management regimens when in 100-seed weight. The harvest index was higher in the Abontem (0.23) than in Omankwa (0.19), however, there was no significant difference between them. Hoeing at 3, 5 and 7 WAP produced the highest harvest index (0.37) which differed significantly from the control (0.17).

This was due to the reduction in competition for growth resources between the plants and the weeds, thereby increasing dry matter accumulation in the crops in the hoed plots. However, hoeing at 3 WAP did not vary significantly from the control. This might be due to the intense competition between the crops and the weeds for nutrients, soil water and sunlight which leads to the reduction of dry matter accumulation thereby leading to low harvest index results. The harvest index from the study was higher in the Abontem × hoeing at 3, 5 and 7 WAP (0.37) interaction differed significantly from the two varieties

× the control interaction. Abontem and Omankwa × hoeing at 3 WAP did not differ significantly from Abontem and Omankwa × the control. This is in line with a study by Choudhary *et al.* (2016) that all the weed control treatments recorded significantly higher harvest index than the weedy check. The yield of the both maize varieties was not significantly different (P>0.05), however Abontem had greater yield (422.06 kg/ha) than Omankwa (397.81 kg/ha). The yield for the current was however lower than the projected yields in both varieties in the country. Abontem and Omankwa varieties each have a yield potential of 4700 kg/ha and 5000 kg/ha, respectively (CSIR, 2019). Similarly, the yield of maize in Ghana in 2018 was 2260 kg/ha, which is also greater than the yields obtained for this current study (MoFAStats, 2017). This may be due to how the different maize varieties responded to weed management strategies as well as other factors such as poor soil fertility, unfavourable weather conditions such as erratic rainfall, high temperatures experienced during the cropping period.

The difference between the weed control regimes and the control was statistically significant (P≤0.05). This results from the provision of season long growth resources to the plants causing increased in grain yield. Hoeing at 3 and 5 WAP had yield of (693.90 kg/ha), although there was no significantly different from other regimes. A research by Tursun *et al.* (2016) found that the weed-control regimes yielded greater yields that were significantly different from the weedy check plots for three maize varieties, supporting this current study's findings. Grain yield was higher for different weed control methods which significantly differed from the control (Adeyemi *et al.* 2019). Only the Abontem and Omankwa x hoeing at 3 and 5 WAP, as well as Omankwa x hoeing at 3, 5 and 7 WAP, were significantly affected by the interaction effect. The maximum yield, (836.10 kg/ha), was produced by the Omankwa variety with hoeing at WAP 3, 5, and 7, while the lowest yield (80.80 kg/ha), was produced by the Abontem variety and the no-hoeing interaction. This finding was similar to that of Osman *et al.* (2020), who opined that two hand weeding of some rice varieties led to greater yields that were substantially different from those obtained with no weeding.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

It can be concluded from the study that, the different weed control regimes had a positive effect on the growth and yield of early maturing maize varieties. The Abontem variety recorded early days to 50% silking (59) which was significantly different ($P \leq 0.05$) from the Omankwa variety which showed late days to 50% silking (64). The hoeing regimes significantly differed from the no hoeing in stem diameter at 7, 9 and 11 WAP. The varieties x hoeing regimes interaction significantly differed from the varieties x no hoeing interaction. Hoeing at 3 and 5 WAP produced significantly higher yield than no hoeing. Omankwa variety × hoeing at 3, 5 and 7 WAP had significantly higher yield (836.10 kg/ha) than Abontem and Omankwa + no hoeing (81 and 87 kg/ha) respectively.

6.2 Recommendations

Based on the study results, the following recommendations were made:

1. Farmers should undertake hand hoeing at 3 and 5 WAP when planting early maturing maize varieties. This will lead to improved vegetative growth and higher yields.
2. Agricultural extension services should promote and educate farmers about the need to practice hand hoeing in cultivating early maturing varieties of maize, highlighting the use of two hand hoeing at 3 and 5 WAP.
3. Further research is recommended to be conducted to investigate the effect of different weed control regimes on other crops that will enhance higher growth and yield and in other agroecological zone to validate the results.
4. Policymakers and stakeholders in the agricultural sector should develop supportive policies and initiatives to encourage the adoption of different weed control regimes

such as hand hoeing, targeting to reduce reliance on chemical weed control to help the venerable and the poor to also engage in farming with less cost and harm to the environment.

By implementing these recommendations, farmers can increase maize production, reduce health risk, and contribute to more sustainable agricultural practices.

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APPENDICES

Appendix 1: Analysis of variance for Percentage Plant Establishment

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	3.25	1.625	1.17	
Varieties	1	0.667	0.667	0.48	0.499
Hoeing Regimes	3	0.833	0.278	0.2	0.894
Varieties × Hoeing Regimes	3	2.333	0.778	0.56	0.65
Error	14	19.417	1.387		
Total	23	26.5			

Appendix 2: Analysis of Variance for Days to 50% Silking

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	9.75	4.875	0.55	
Varieties	1	198.375	198.375	22.35	<.001
Hoeing Regimes	3	895.125	298.375	33.62	<.001
Varieties × Hoeing Regimes	3	90.125	30.042	3.38	0.048
Error	14	124.25	8.875		
Total	23	1317.63			

Appendix 3: Analysis of Variance for Plant height (cm)

Appendix 3a: Plant height (cm) at 5 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	10.788	5.394	1.46	
Varieties	1	13.157	13.157	3.55	0.08
Hoeing Regimes	3	2.841	0.947	0.26	0.856
Varieties × Hoeing Regimes	3	10.85	3.617	0.98	0.432
Error	14	51.836	3.703		
Total	23	89.472			

Appendix 3b: Plant height (cm) at 7 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	34.82	17.41	1.3	
Varieties	1	58.97	58.97	4.4	0.055
Hoeing Regimes	3	25.02	8.34	0.62	0.612
Varieties × Hoeing Regimes	3	43.53	14.51	1.08	0.388
Error	14	187.57	13.4		
Total	23	349.9			

Appendix 3c: Plant height (cm) at 9 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	4995.4	2497.7	5.67	
Varieties	1	54.5	54.5	0.12	0.73
Hoeing Regimes	3	1716.9	572.3	1.3	0.314
Varieties × Hoeing Regimes	3	229.1	76.4	0.17	0.913
Error	14	6171.6	440.8		
Total	23	13167.4			

Appendix 3d: Plant height (cm) at 11 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	9684.6	4842.3	16.11	
Varieties	1	8.8	8.8	0.03	0.867
Hoeing Regimes	3	2252.3	750.8	2.5	0.102
Varieties × Hoeing Regimes	3	668.6	222.9	0.74	0.545
Error	14	4206.9	300.5		
Total	23	16821.1			

Appendix 4: Analysis of Variance for Stem diamter (cm)

Appendix 4a: Stem diameter (cm) at 5 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.01839	0.0092	0.44	
Varieties	1	0.108	0.108	5.12	0.04
Hoeing Regimes	3	0.05216	0.01739	0.82	0.502
Varieties × Hoeing Regimes	3	0.02398	0.00799	0.38	0.77
Error	14	0.2956	0.02111		
Total	23	0.49814			

Appendix 4b: Stem diameter (cm) at 7 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.0387	0.01935	1.97	
Varieties	1	0.12013	0.12013	12.22	0.004
Hoeing Regimes	3	0.61953	0.20651	21.01	<.001
Varieties × Hoeing Regimes	3	0.01759	0.00586	0.6	0.628
Error	14	0.13762	0.00983		
Total	23	0.93357			

Appendix 4c: Stem diameter (cm) 9 at WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.09616	0.04808	2.93	
Varieties	1	0.09041	0.09041	5.51	0.034
Hoeing Regimes	3	0.98967	0.32989	20.11	<.001
Varieties × Hoeing Regimes	3	0.01242	0.00414	0.25	0.858
Error	14	0.22962	0.0164		
Total	23	1.41828			

Appendix 4d: Stem diamter (cm) at 11 WAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.09026	0.04513	2.1	
Varieties	1	0.01131	0.01131	0.53	0.48
Hoeing Regimes	3	1.22739	0.40913	19.04	<.001
Varieties × Hoeing Regimes	3	0.05812	0.01937	0.9	0.465
Error	14	0.3009	0.02149		
Total	23	1.68798			

Appendix 5: Analysis of Variance for Number of Plants Harvested

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	25.33	12.67	0.58	
Varieties	1	1.5	1.5	0.07	0.797
Hoeing Regimes	3	150.33	50.11	2.29	0.123
Varieties × Hoeing Regimes	3	43.5	14.5	0.66	0.589
Error	14	306.67	21.9		
Total	23	527.33			

Appendix 6: Analysis of Variance for Number of Cobs per Plant

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	1.0208	0.5104	1.02	
Varieties	1	0.6667	0.6667	1.34	0.267
Hoeing Regimes	3	56.7083	18.9028	37.92	<.001
Varieties × Hoeing Regimes	3	0.0833	0.0278	0.06	0.982
Error	14	6.9792	0.4985		
Total	23	65.4583			

Appendix 7: Analysis of Variance for Number of Cob per Plot

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	68.08	34.04	2.17	
Varieties	1	0.17	0.17	0.01	0.919
Hoeing Regimes	3	2280.83	760.28	48.4	<.001
Varieties × Hoeing Regimes	3	136.83	45.61	2.9	0.072
Error	14	219.92	15.71		
Total	23	2705.83			

Appendix 8: Analysis of Variance for Stover weight per plot (kg)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	1.9344	0.9672	1.26	
Varieties	1	3.8801	3.8801	5.07	0.041
Hoeing Regimes	3	33.1592	11.0531	14.45	<.001
Varieties × Hoeing Regimes	3	8.2831	2.761	3.61	0.04
Error	14	10.7087	0.7649		
Total	23	57.9656			

Appendix 9: Analysis of Variance for Husked Cob weight per plot (kg)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block	2	0.2422	0.1211	0.46	
Hoeing Regime	1	0.1121	0.1121	0.43	0.524
Varieties	3	8.1385	2.7128	10.34	<.001
Hoeing Regime x Varieties	3	0.3033	0.1011	0.39	0.765
Error	14	3.6734	0.2624		
Total	23	12.4695			

Appendix 10: Analysis of Variance for Seed Weight per Plant (g)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	24470	12235	1.1	
Varieties	1	30990	30990	2.78	0.117
Hoeing Regimes	3	445755	148585	13.35	<.001
Varieties × Hoeing Regimes	3	44503	14834	1.33	0.304
Error	14	155873	11134		
Total	23	701590			

Appendix 11: Analysis of Variance for Seed weight per plot (kg)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.07527	0.03763	0.44	
Varieties	1	0.08686	0.08686	1.01	0.331
Hoeing Regimes	3	3.75136	1.25045	14.59	<.001
Varieties × Hoeing Regimes	3	0.37482	0.12494	1.46	0.268
Error	14	1.1995	0.08568		
Total	23	5.48781			

Appendix 12: Analysis of Variance for 100-Seed weight (g)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	7.32	3.66	0.29	
Varieties	1	5.88	5.88	0.47	0.506
Hoeing Regimes	3	254.97	84.99	6.73	0.005
Varieties × Hoeing Regimes	3	65.79	21.93	1.74	0.205
Error	14	176.81	12.63		
Total	23	510.76			

Appendix 13: Analysis of Variance for Yield (kg/h)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	18816	9408	0.44	
Varieties	1	21716	21716	1.01	0.331
Hoeing Regimes	3	937841	312614	14.59	<.001
Varieties × Hoeing Regimes	3	93705	31235	1.46	0.268
Error	14	299875	21420		
Total	23	1371952			

Appendix 14: Analysis of Variance for Harvest Index

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	0.004	0.002	0.46	
Varieties	1	0.0085	0.0085	1.95	0.184
Hoeing Regimes	3	0.18109	0.06036	13.88	<.001
Varieties × Hoeing Regimes	3	0.01326	0.00442	1.02	0.415
Error	14	0.0609	0.00435		
Total	23	0.26775			